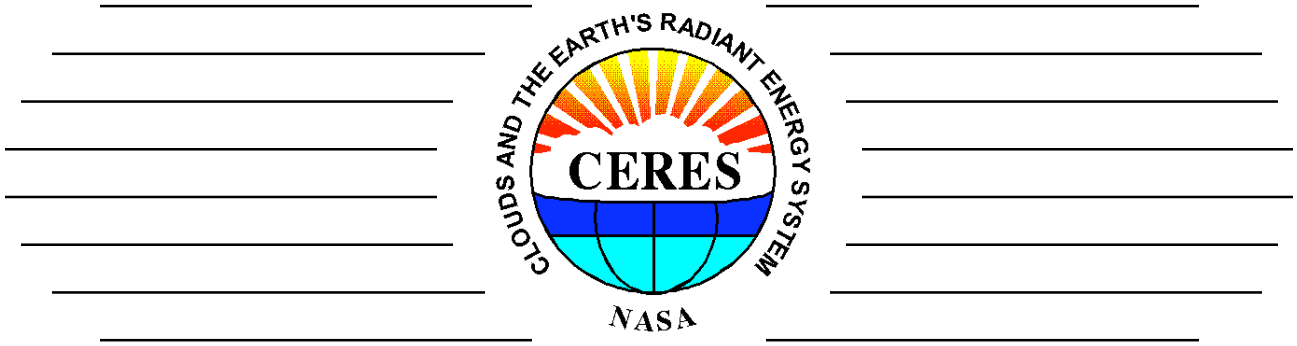
CERES Instrument Cal/Val Report



Kory J. Priestley
Robert Lee, Susan Thomas, Aiman Al-Hajjah,
Robert Wilson, Pete Spence, Ed Kizer, Peter Szewczyk
Phil Hess, Joey Escuadra, Denise Cooper, Dale Walikainen,
Mike Cisewski, Bill Vogler, Jim Bailey

29th CERES Science Team Meeting
Hampton, VA

NASA Langley Research Center
Atmospheric SCIENCES

INSTRUMENT WORKING GROUP

CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM

Introduction | Activities | Documentation | Operations | Production | Data | Personnel

ACTIVITIES

Choose from one of the links below:

Ground Calibration

Deep Space Calibration

Validation

Field Campaigns:

CLAMS CRYSTAL-FACE INDOEX
LaRC-ULDB GERB Aerosols
Terra/Aqua Intercalibration
Solar Principal Plane Scans (PPS)

Event Calendar: 2003

NASA LaRC

Last Updated: Tue Apr 29 13:03:55 2003
Web Curator: Phil Hess (p.c.hess@larc.nasa.gov)
Responsible NASA Official: Kory Priestley (k.j.priestley@larc.nasa.gov)

CERES Home Page


INSTRUMENT WORKING GROUP
CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM
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Event Calendar:
2003
http://asd-www.larc.nasa.gov/Instrument/
NASA LaRC
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CERES Home Page

Instrument Operations

OCTOBER						
SUN	MON	TUE	WED	THU	FRI	SAT
			10/1 [274] Solcal/IntCal	10/2 [275]	10/3 [276] BB IntCal	10/4 [277]
10/5 [278]	10/6 [279] BB IntCal	10/7 [280]	10/8 [281] IntCal	10/9 [282]	10/10 [283] BB IntCal	10/11 [284]
10/12 [285]	10/13 [286] BB IntCal Holiday	10/14 [287]	10/15 [288] Solcal/IntCal	10/16 [289]	10/17 [290] FM3: PPS Test BB IntCal	10/18 [291] FM3: PPS Test
10/19 [292] FM3: PPS Test	10/20 [293] FM2/3: PPS Test BB IntCal	10/21 [294] FM2/3: PPS Test	10/22 [295] FM2/3: PPS Test IntCal	10/23 [296] FM2/3: PPS Test	10/24 [297] FM2/3: PPS Test BB IntCal	10/25 [298] FM2/3: PPS Test
10/26 [299] FM2/3: PPS Test	10/27 [300] FM2/3: PPS Test BB IntCal	10/28 [301] FM2/3: PPS Test	10/29 [302] FM2/3: PPS Test Solcal/IntCal	10/30 [303] FM2/3: PPS Test	10/31 [304] FM2/3: PPS Test BB IntCal	

Instrument Operations

NOVEMBER						
SUN	MON	TUE	WED	THU	FRI	SAT
						11/1 [305] FM2/3: PPS Test FM1-4: Diagnostic
11/2 [306] FM2/3: PPS Test	11/3 [307] FM2/3: PPS Test BB IntCal	11/4 [308] FM2/3: PPS Test	11/5 [309] FM2/3: PPS Test IntCal	11/6 [310] FM2/3: PPS Test	11/7 [311] FM2/3: PPS Test BB IntCal	11/8 [312] FM2/3: PPS Test FM1-4: Lunar Eclipse
11/9 [313] FM2/3: PPS Test FM1-4: Lunar Eclipse	11/10 [314] FM2/3: PPS Test BB IntCal	11/11 [315] FM2/3: PPS Test Holiday	11/12 [316] FM2/3: PPS Test Solcal/IntCal	11/13 [317] FM2/3: PPS Test	11/14 [318] FM2/3: PPS Test BB IntCal	11/15 [319] FM2/3: PPS Test
11/16 [320] FM2/3: PPS Test	11/17 [321] FM2/3: PPS Test CERES Science Team Meeting BB IntCal	11/18 [322] FM2/3: PPS Test CERES Science Team Meeting	11/19 [323] FM2/3: PPS Test IntCal	11/20 [324] FM2/3: PPS Test	11/21 [325] FM2/3: PPS Test BB IntCal	11/22 [326] FM2/3: PPS Test
11/23 [327] FM2/3: PPS Test	11/24 [328] FM2/3: PPS Test BB IntCal	11/25 [329] FM2/3: PPS Test	11/26 [330] FM2/3: PPS Test Solcal/IntCal	11/27 [331] FM2/3: PPS Test Holiday	11/28 [332] FM2/3: PPS Test BB IntCal	11/29 [333] FM2/3: PPS Test
11/30 [334] FM2/3: PPS Test						

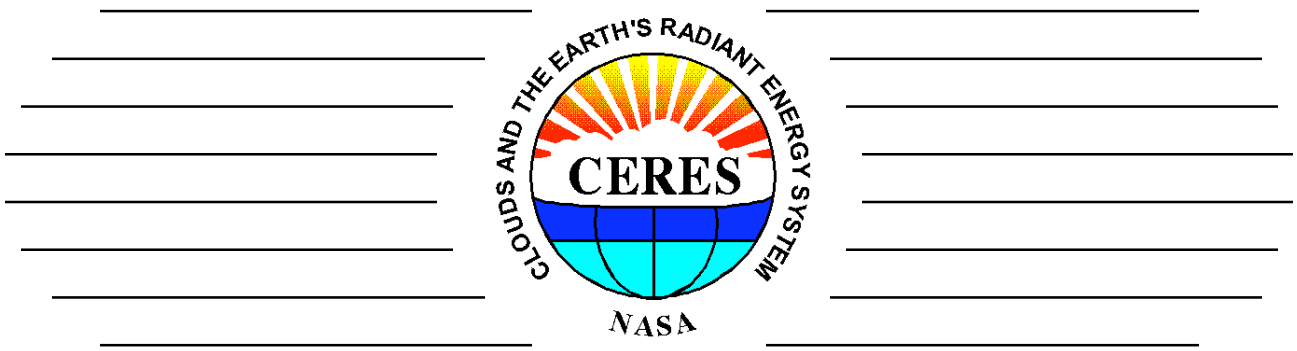
Instrument Operations

DECEMBER						
SUN	MON	TUE	WED	THU	FRI	SAT
	12/1 [335] BB IntCal	12/2 [336]	12/3 [337] IntCal	12/4 [338]	12/5 [339] BB IntCal	12/6 [340] Terra: DSC#3 (?)
12/7 [341]	12/8 [342] BB IntCal	12/9 [343]	12/10 [344] Solcal/IntCal	12/11 [345]	12/12 [346] FM3: PPS Test FM2: GERB Test BB IntCal	12/13 [347] FM3: PPS Test FM2: GERB Test
12/14 [348] FM3: PPS Test FM2: GERB Test	12/15 [349] FM3: PPS Test FM2: GERB Test BB IntCal	12/16 [350] FM3: PPS Test FM2: GERB Test	12/17 [351] FM3: PPS Test FM2: GERB Test IntCal	12/18 [352] FM3: PPS Test FM2: GERB Test	12/19 [353] FM3: PPS Test FM2: GERB Test BB IntCal	12/20 [354] FM3: PPS Test FM2: GERB Test
12/21 [355] FM3: PPS Test FM2: GERB Test	12/22 [356] FM3: PPS Test FM2: GERB Test BB IntCal	12/23 [357] FM3: PPS Test FM2: GERB Test	12/24 [358] FM3: PPS Test FM2: GERB Test Solcal/IntCal	12/25 [359] FM3: PPS Test FM2: GERB Test Holiday	12/26 [360] FM3: PPS Test FM2: GERB Test BB IntCal	12/27 [361] FM3: PPS Test FM2: GERB Test
12/28 [362] FM3: PPS Test FM2: GERB Test	12/29 [363] FM3: PPS Test FM2: GERB Test BB IntCal	12/30 [364] FM3: PPS Test FM2: GERB Test	12/31 [365] FM3: PPS Test FM2: GERB Test IntCal			

BDS and ERBE-Like Product Status

Spacecraft	Product	Version	Available	Months Processed
Terra	BDS	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 6/03
	ERBE-like	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 6/03
Aqua	BDS	Edition1	Yes	6/02 - present
		Edition2	1/04	6/02 - present
	ERBE-like	Edition1	Yes	7/02 - present
		Edition2	1/04	7/02 - present

Terra Status Report



Instrument Working Group

May 6, 2003

NASA Langley Research Center

Atmospheric SCIENCES

Edition2 BDS and ERBE-Like Products: Drift Removal Methodology

Drifts are modeled as originating from either of 2 physical entities…..

- **Radiometric Gain Change**
  - **Wavelength independent change in sensor responsivity**
  - **Corrections implemented in Count Conversion algorithm (SS1)**

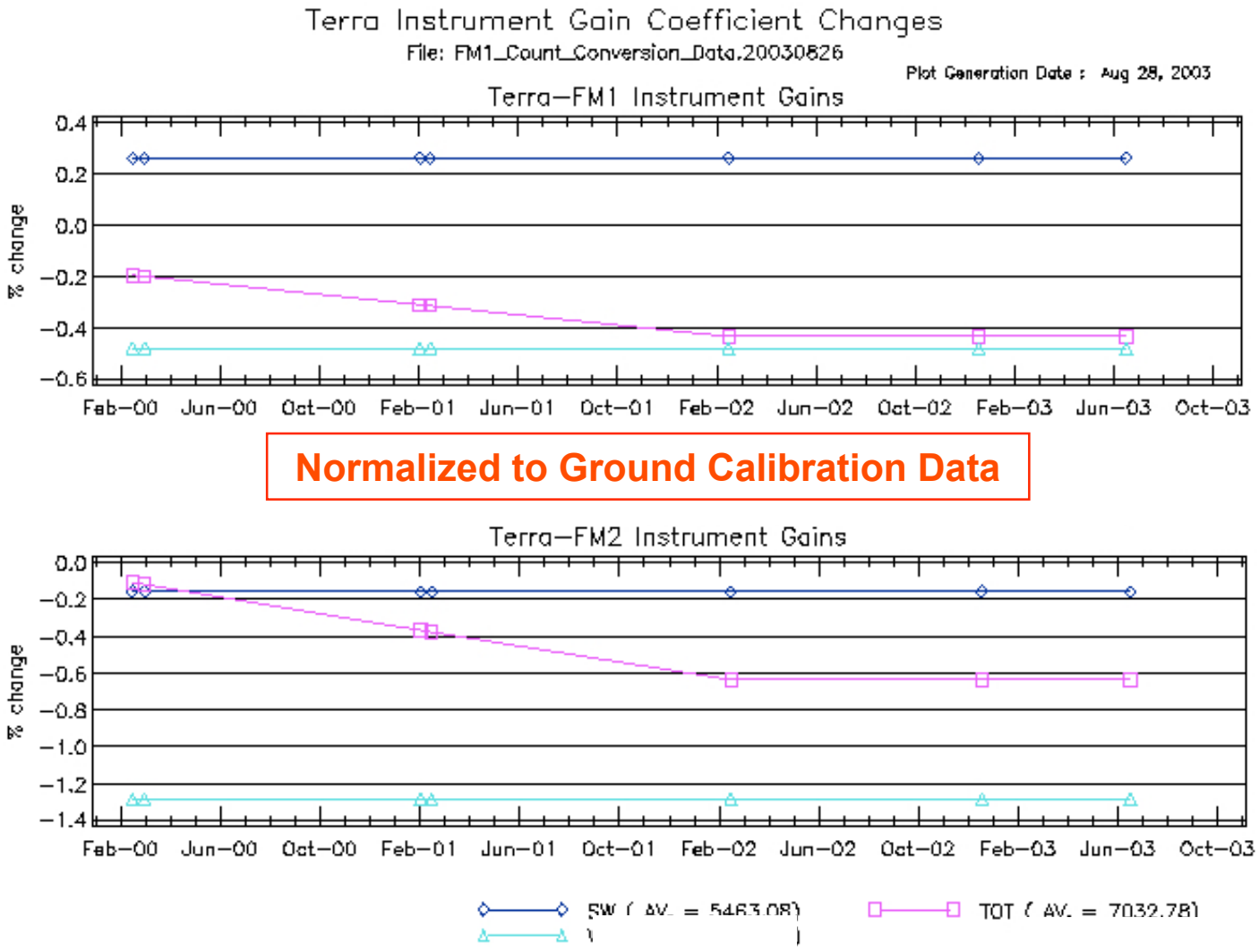
- **Spectral Response Change**
  - **Wavelength dependent change in sensor absorptivity**
  - **Corrections implemented in Spectral Unfiltering algorithms (SS2)**

- **Updated Radiometric Gains and Spectral Response Functions will be generated on a monthly basis and will be implemented on either a daily (Gains) or monthly (Spectral) interpolated basis.**

Instrument Group has delivered corrections for the first 34 months of Terra data. Testing is still occuring for Jan-03 to present.

Terra BDS Edition 2 Changes

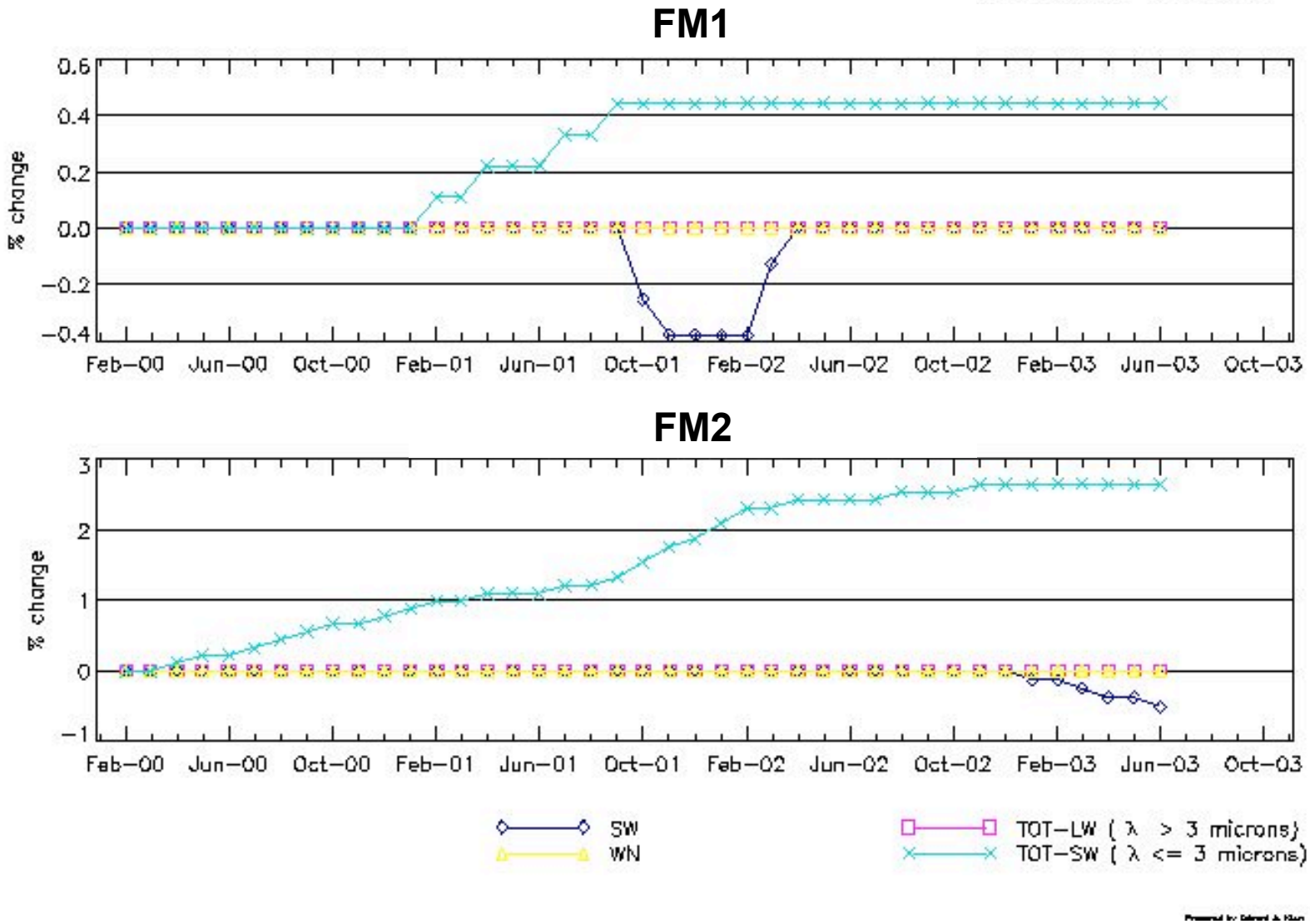
By Channel and Date



Normalized to Ground Calibration Data

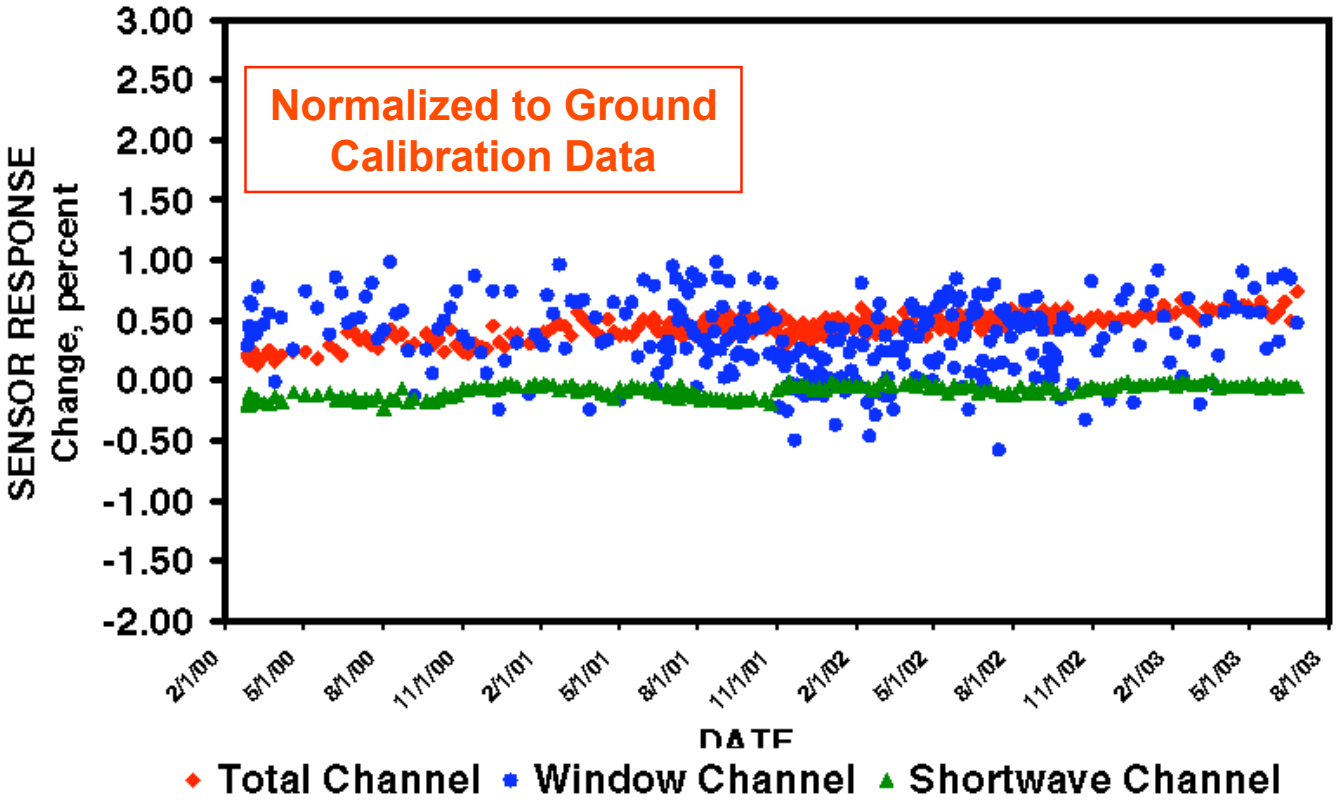
Terra ERBE-Like Edition 2 Changes

Spectral Response Function % change



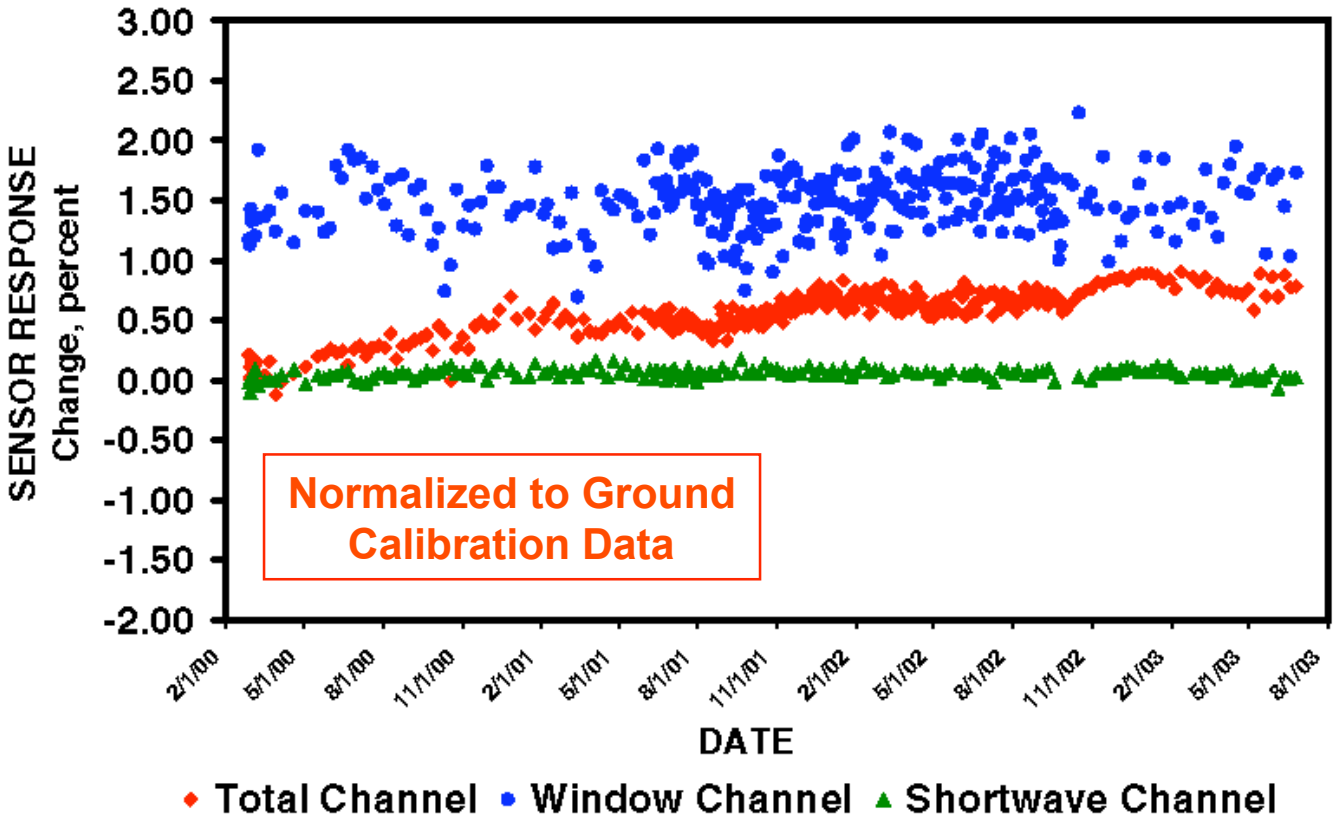
Terra/Flight Model 1
Lifetime Radiometric Stability

Determined with the Internal Calibration Module



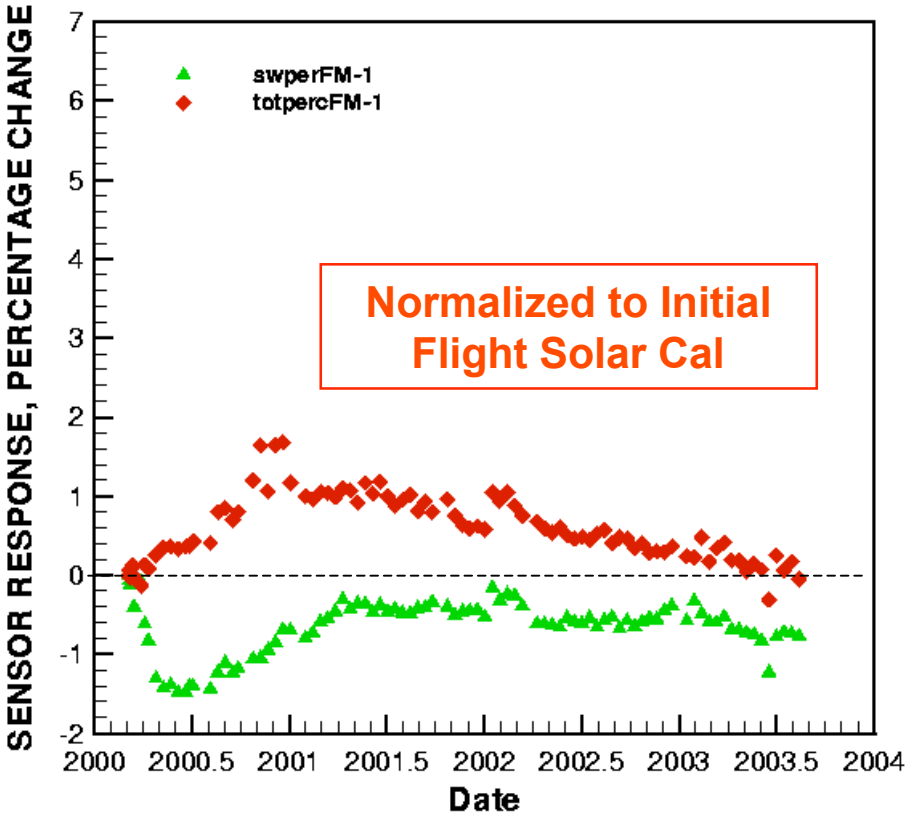
Terra/Flight Model 2
Lifetime Radiometric Stability

Determined with the Internal Calibration Module

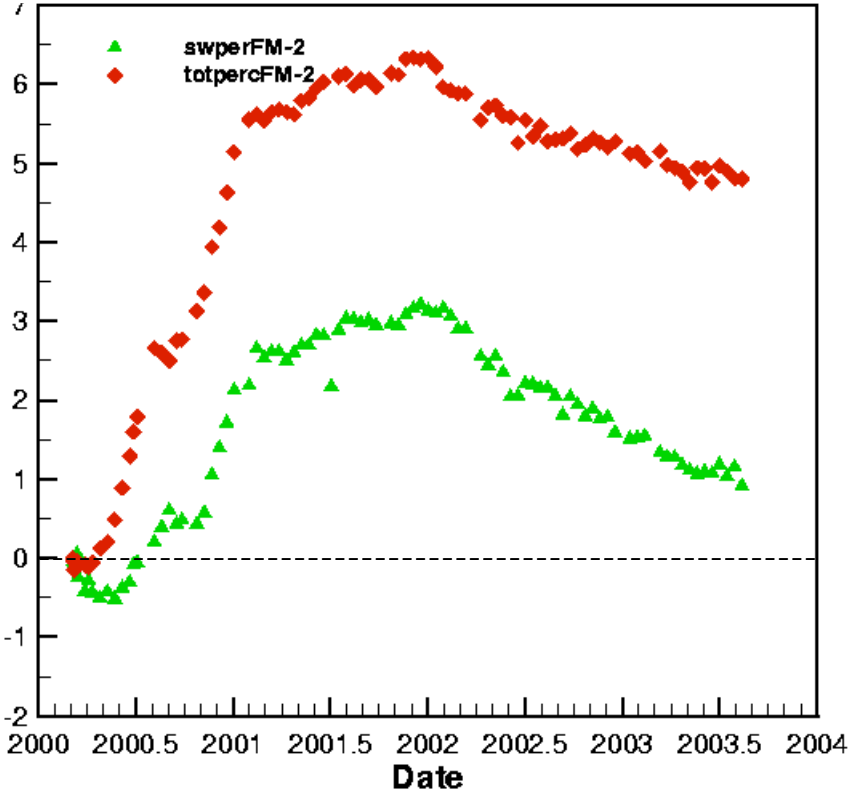


Terra/Flight Model 1&2
On-Orbit Radiometric Stability

Determined with the Mirror Attenuator Mosaic (MAM)



FM 1

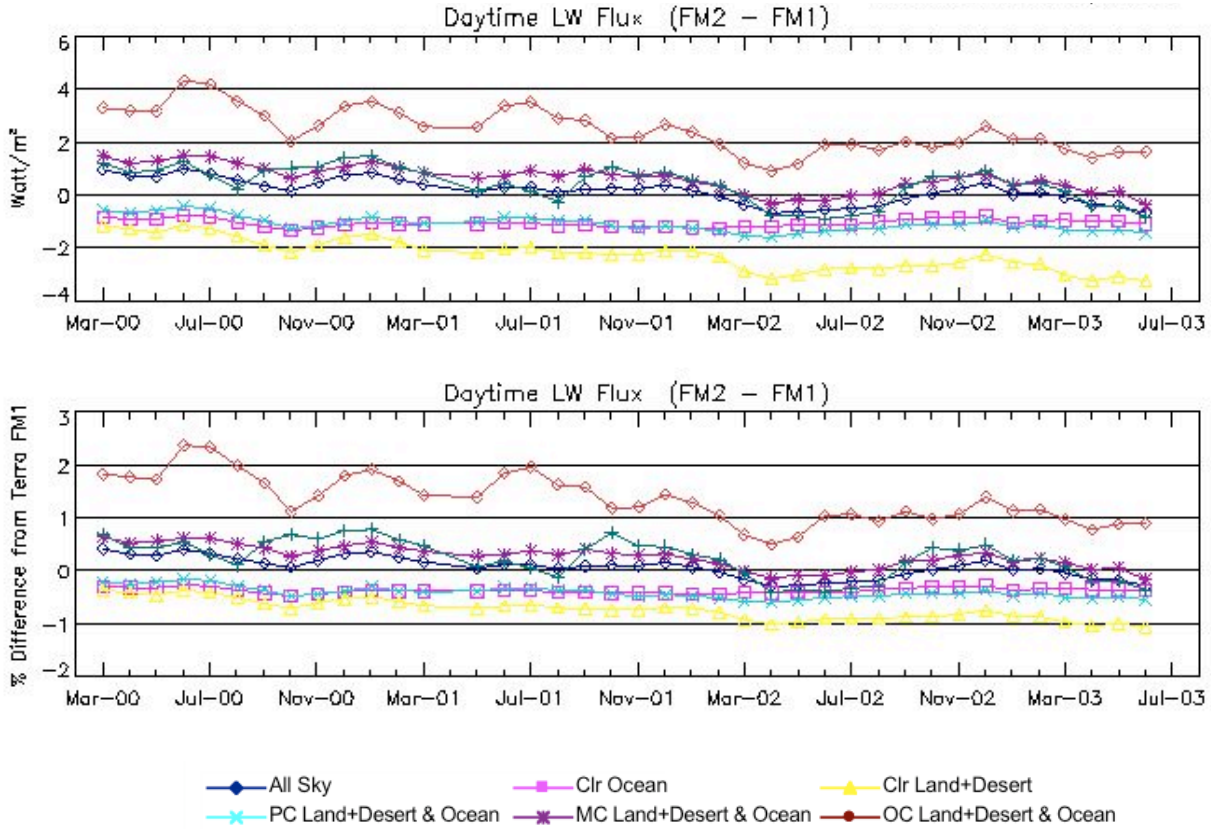


FM 2

Terra Direct Comparison

Edition2 Daytime LW Flux

Co-located Nadir Measurements



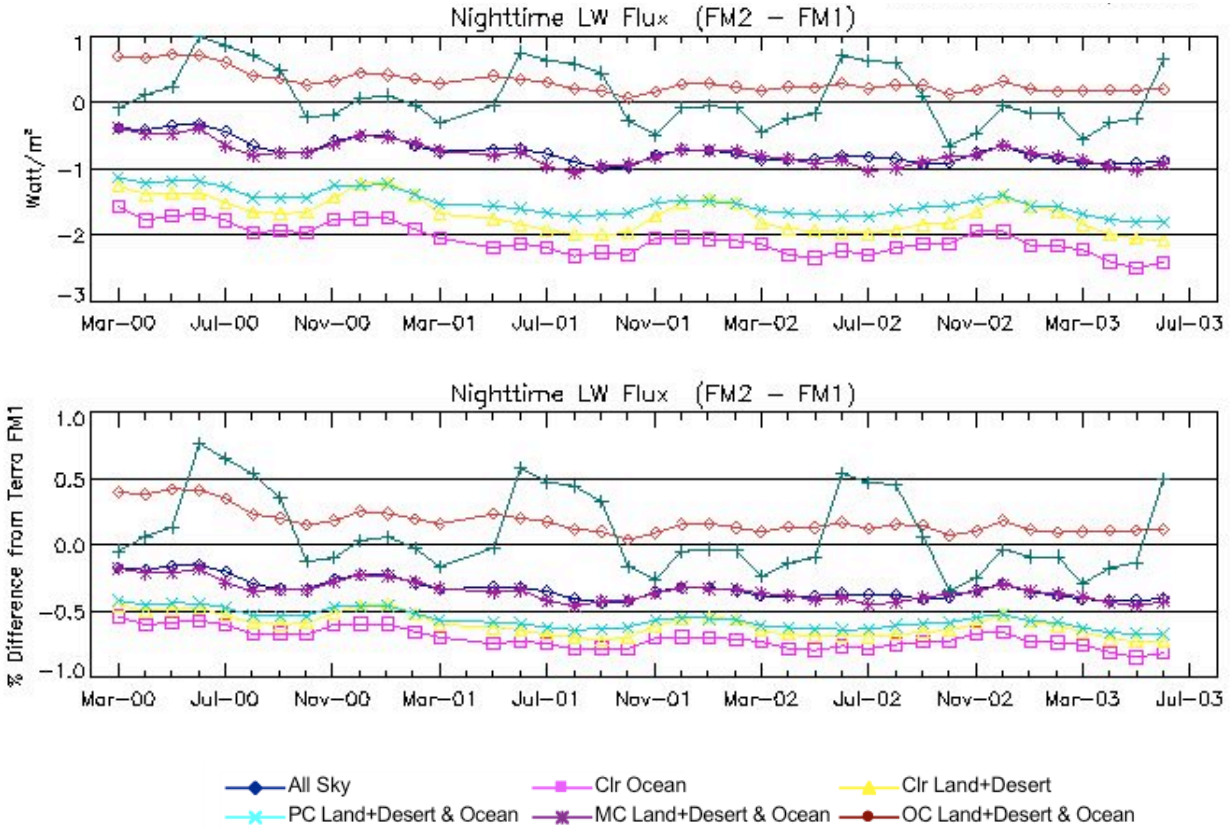
Absolute Difference

Percent Difference

Terra Direct Comparison

Edition2 Nighttime LW Flux

Co-located Nadir Measurements



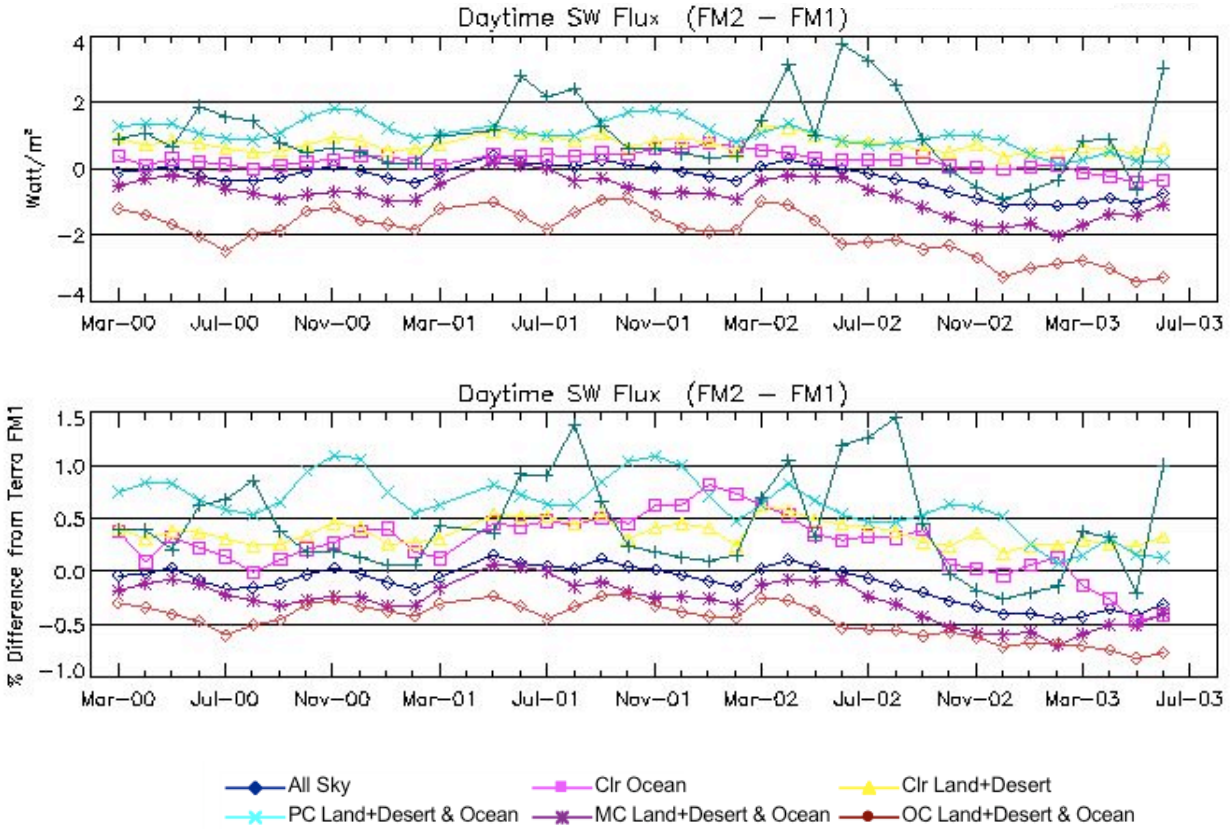
Absolute Difference

Percent Difference

Terra Direct Comparison

Editon2 SW Flux

Co-located Nadir Measurements



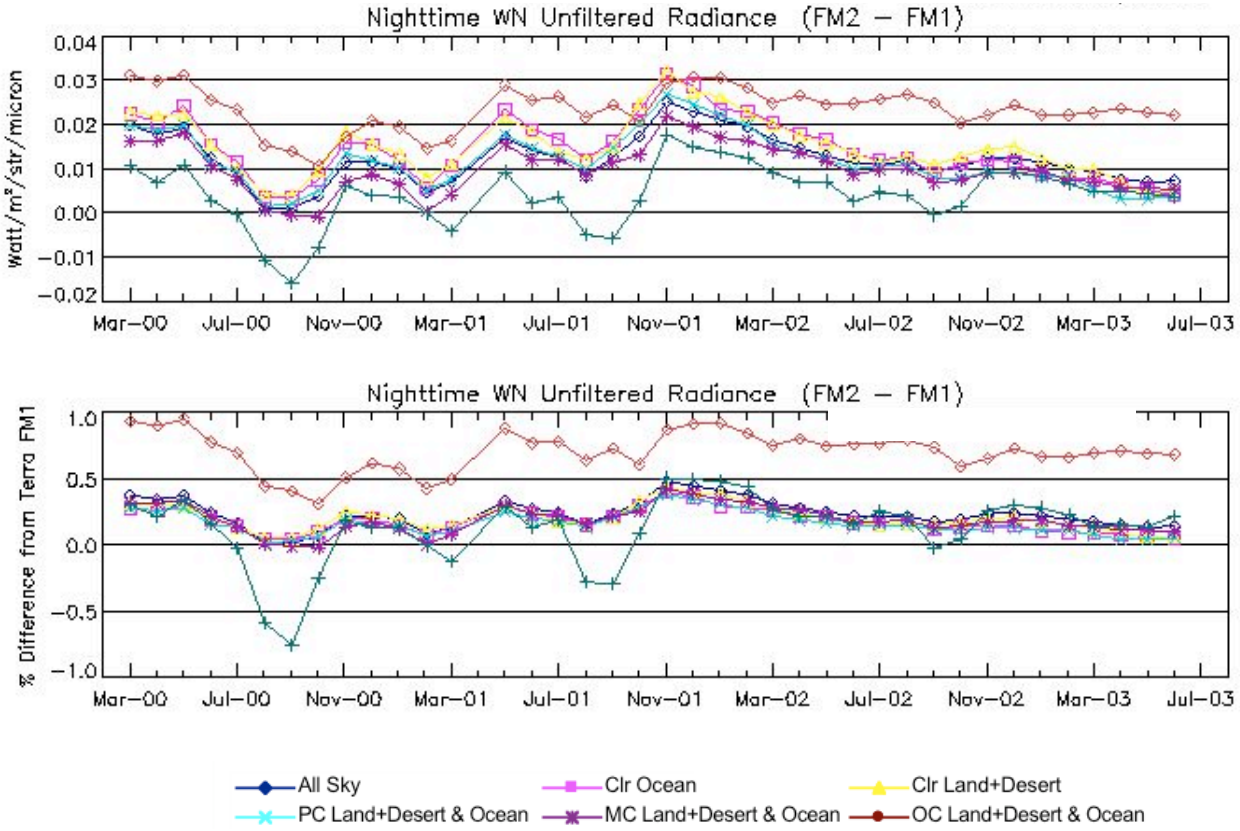
Absolute Difference

Percent Difference

Terra Direct Comparison

Edition2 Nighttime WN Radiance

Co-located Nadir Measurements



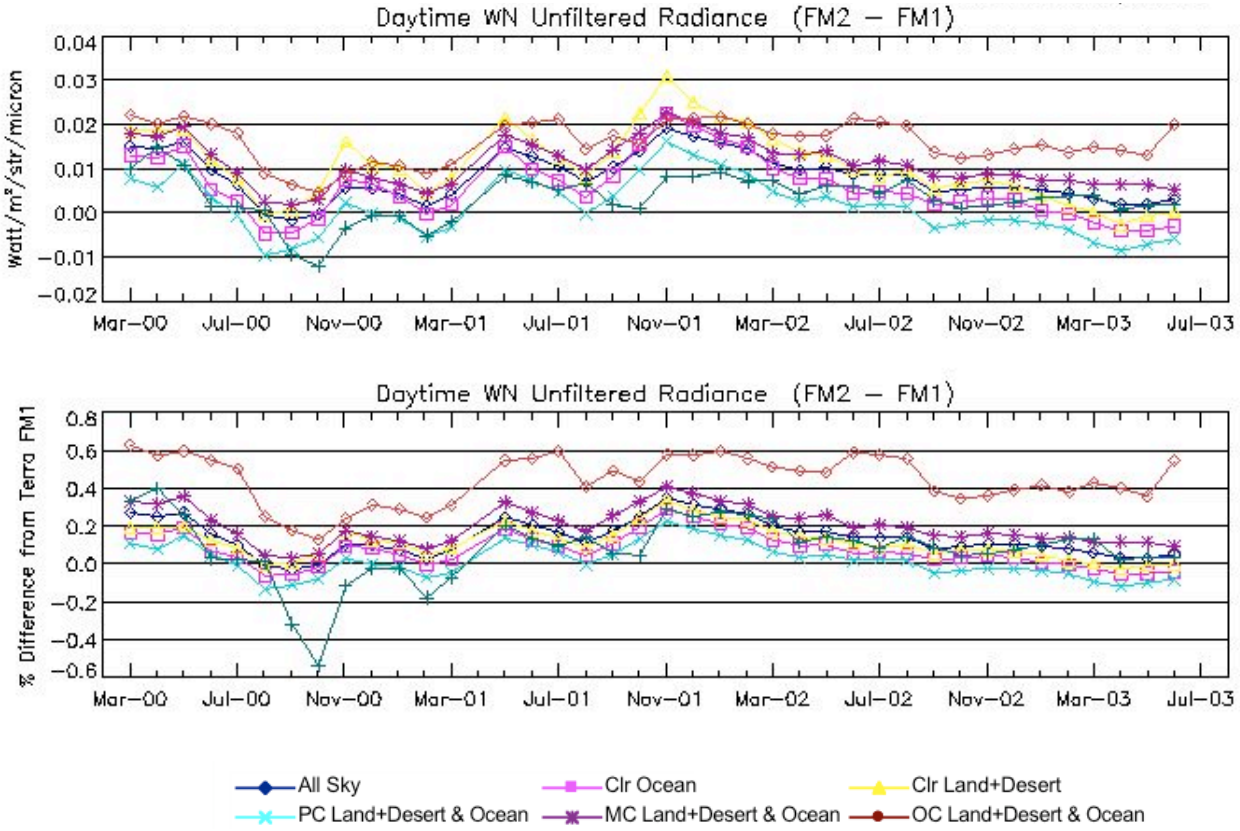
Absolute Difference

Percent Difference

Terra Direct Comparison

Edition2 Daytime WN Radiance

Co-located Nadir Measurements



Absolute Difference

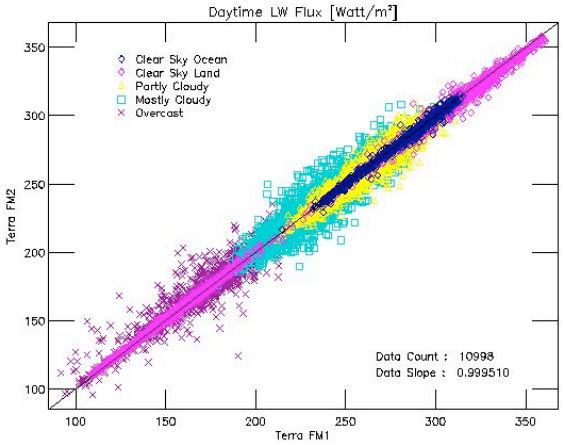
Percent Difference

Terra Direct Comparison

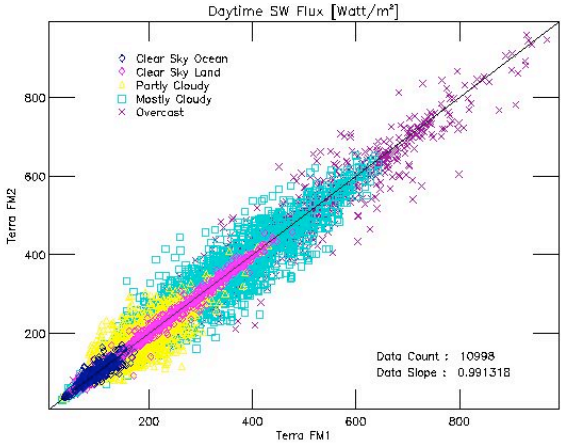
Editon2 ES-8 LW & SW Fluxes, WN radiances

October 15, 2002

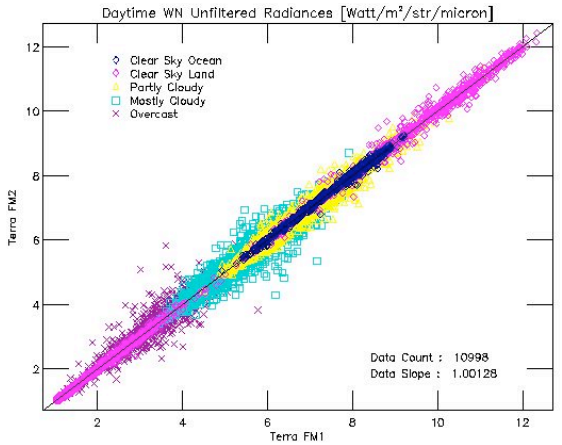
LW

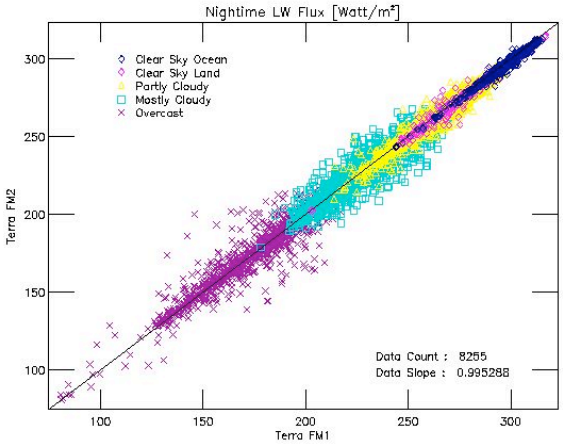


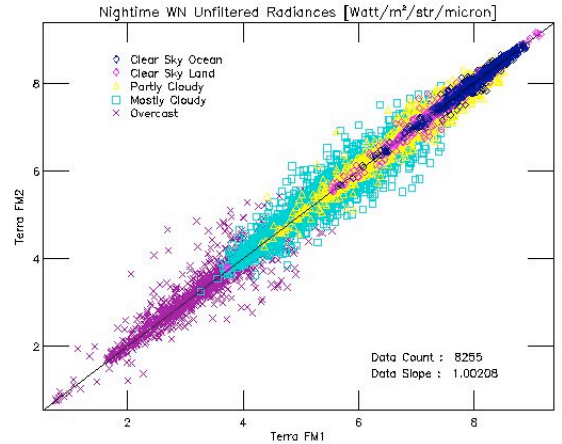
SW



WN



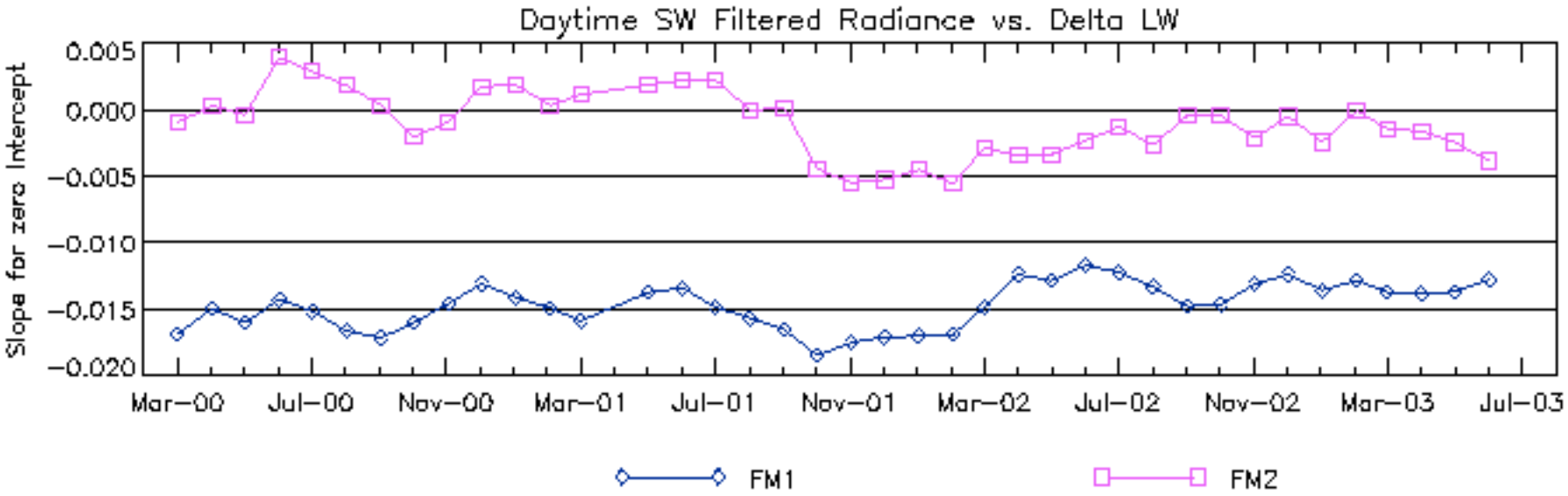




3-Channel Intercomparison

Monthly Unfiltering %-Error

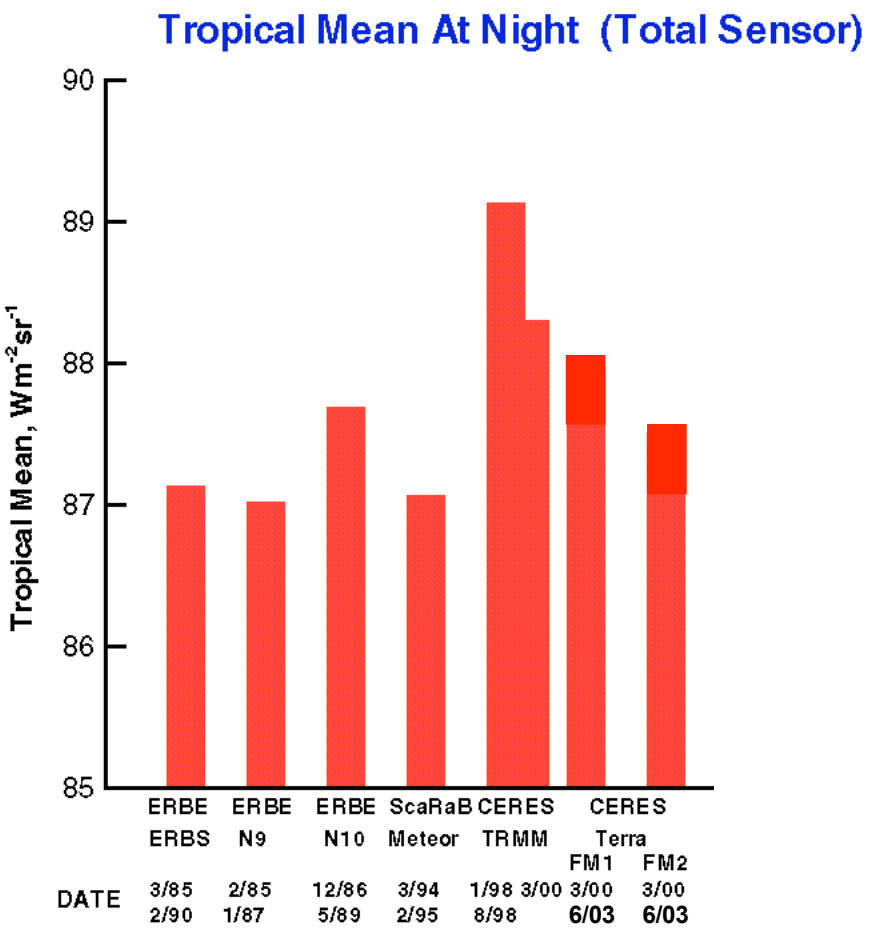
Edition2



Tropical Mean Statistic

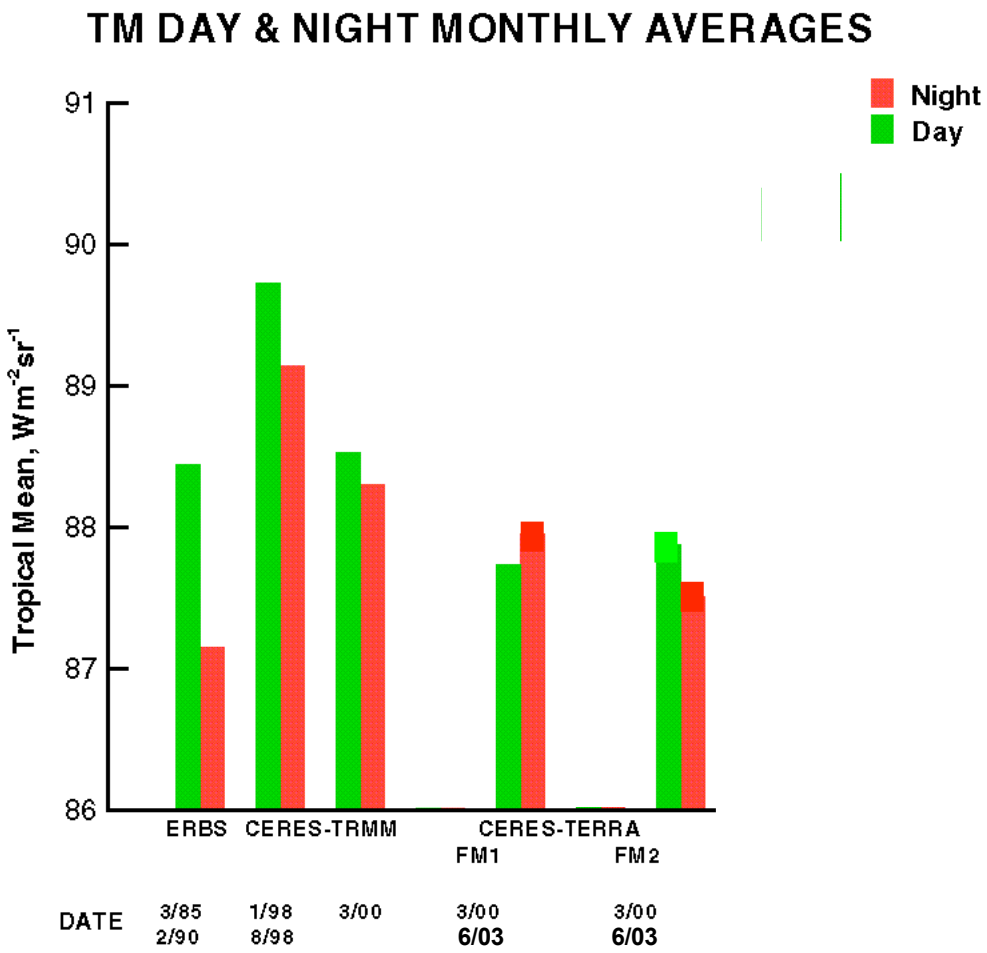
Tropical Ocean All Sky

Terra Ed2, Aqua Ed1



Tropical Mean Statistic

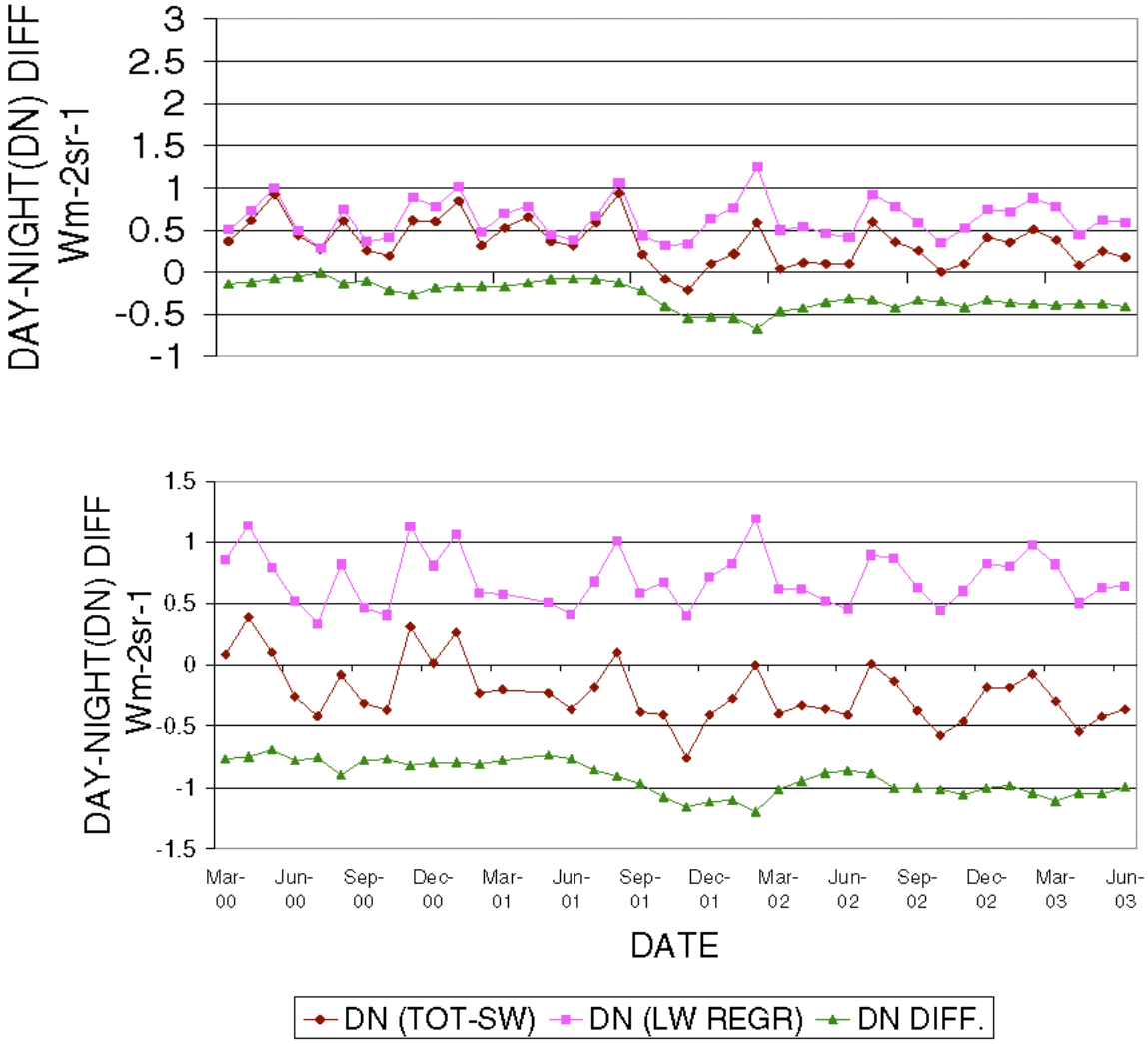
Tropical Ocean All Sky



Tropical Mean Self Consistency

Tropical Ocean All Sky

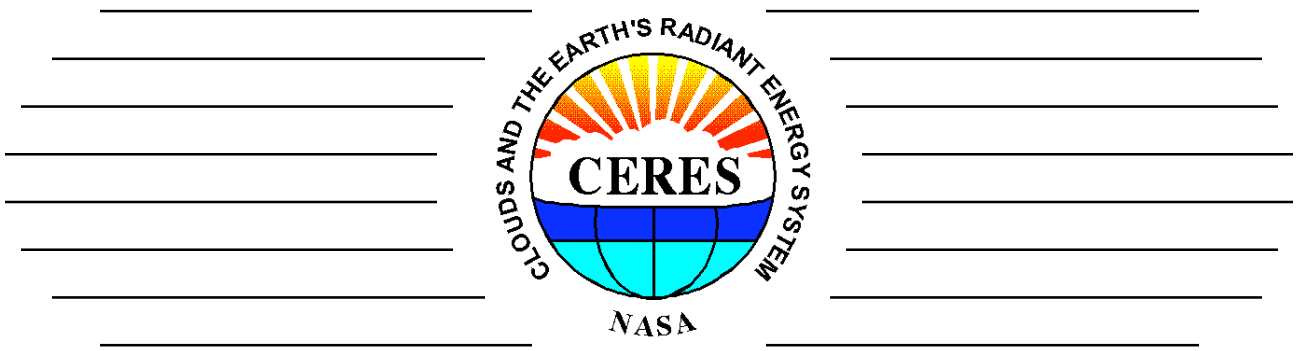
Day-Night Differences



Flight Model 2

Flight Model 1

Aqua Status Report



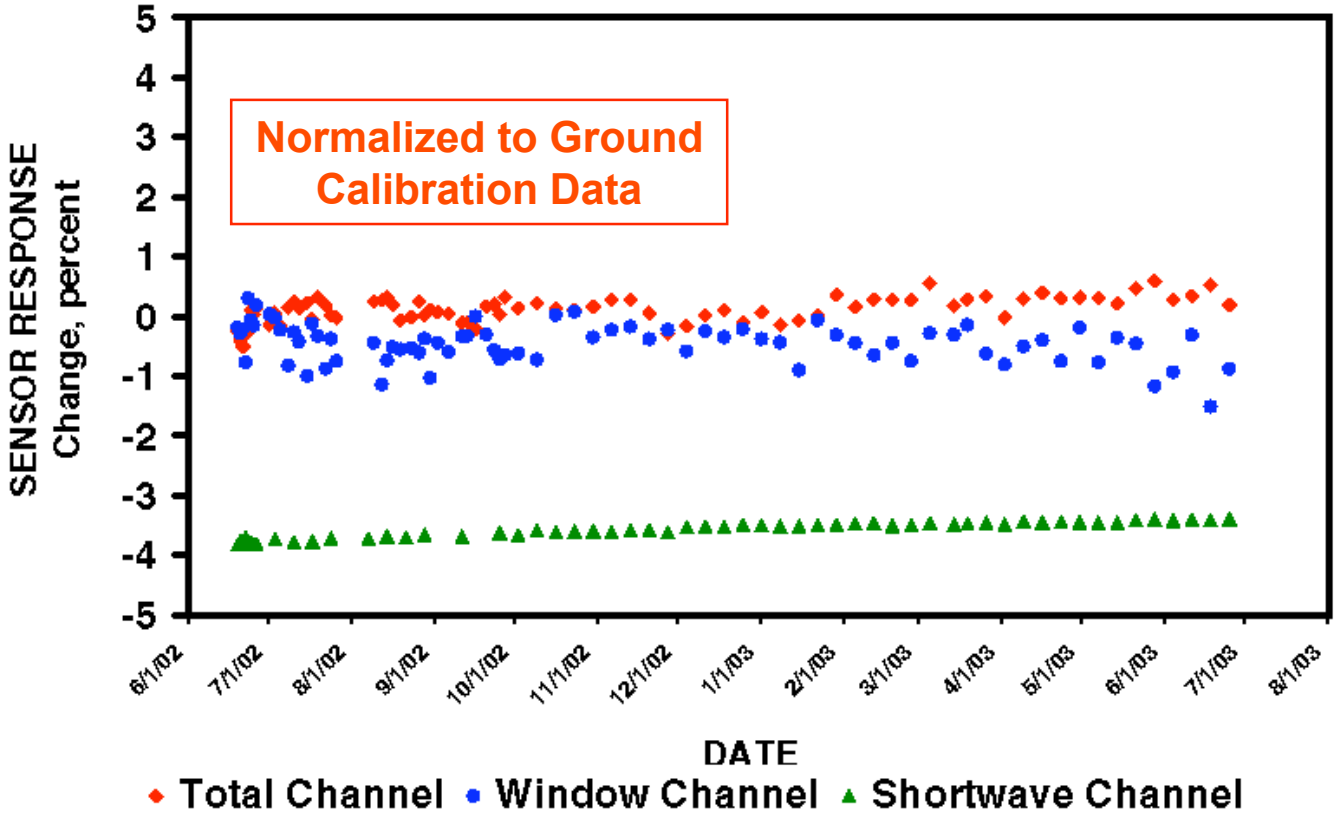
Instrument Working Group

May 6, 2003

NASA Langley Research Center

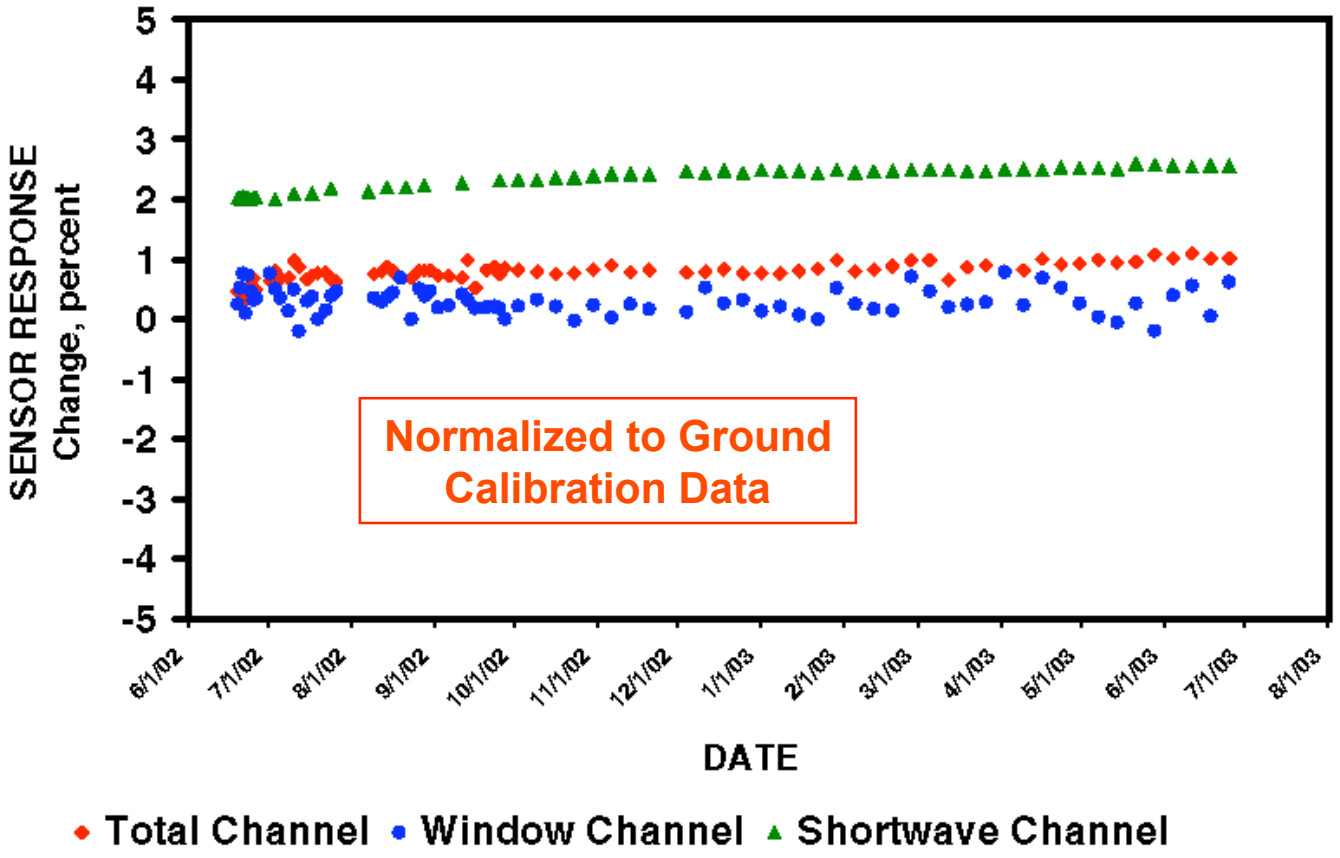
Atmospheric SCIENCES

Aqua/Flight Model 3
Lifetime Radiometric Stability
Determined with the Internal Calibration Module



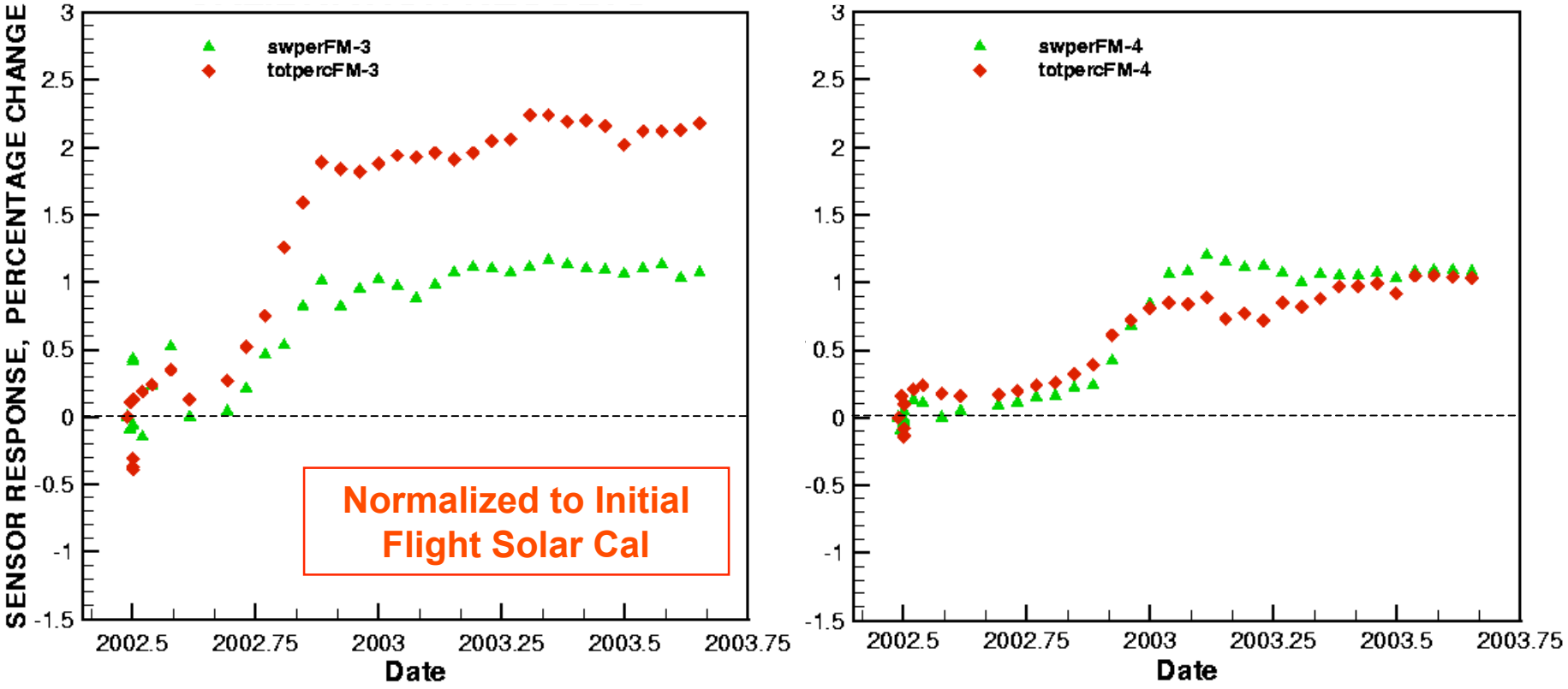
Aqua/Flight Model 4
Lifetime Radiometric Stability

Determined with the Internal Calibration Module



Aqua/Flight Model 3 & 4
On-Orbit Radiometric Stability

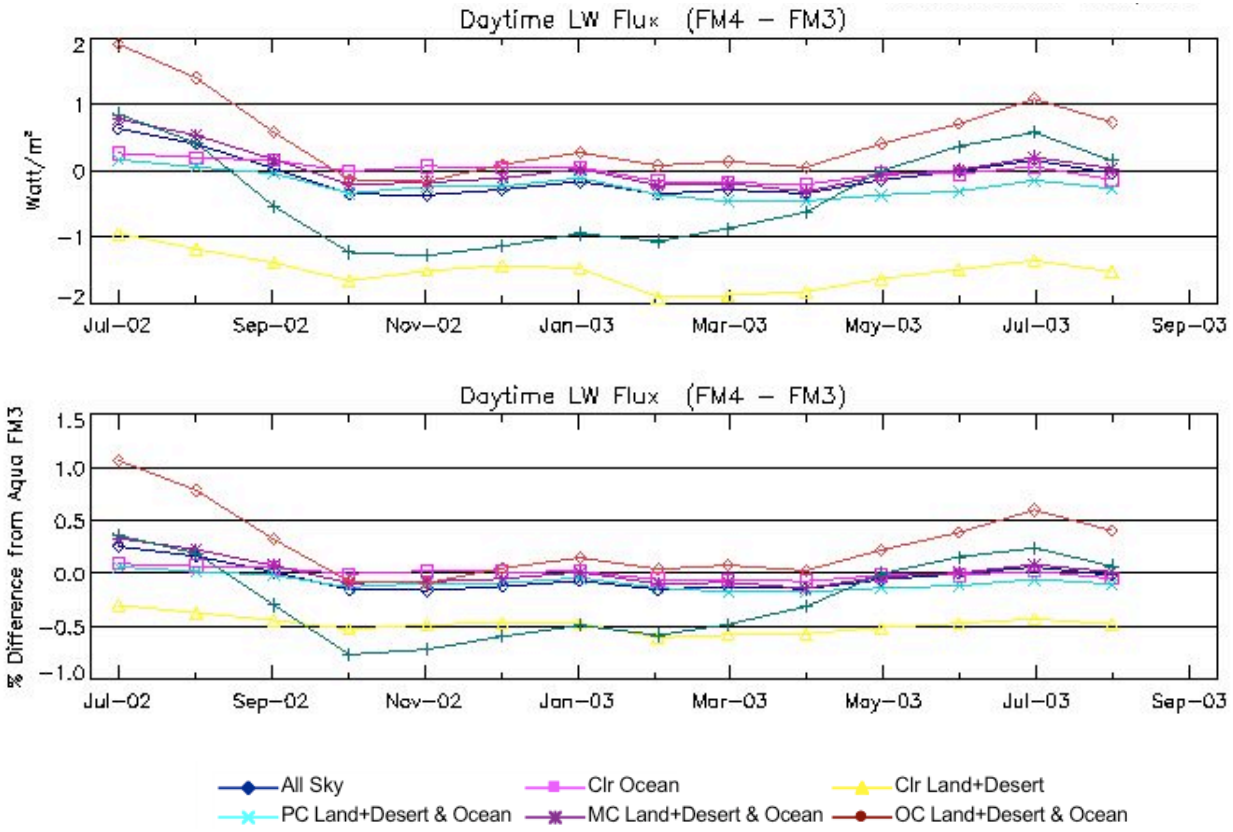
Determined with the Mirror Attenuator Mosaic (MAM)



Aqua Direct Comparison

Edition1 Daytime LW Flux

co-located nadir measurements



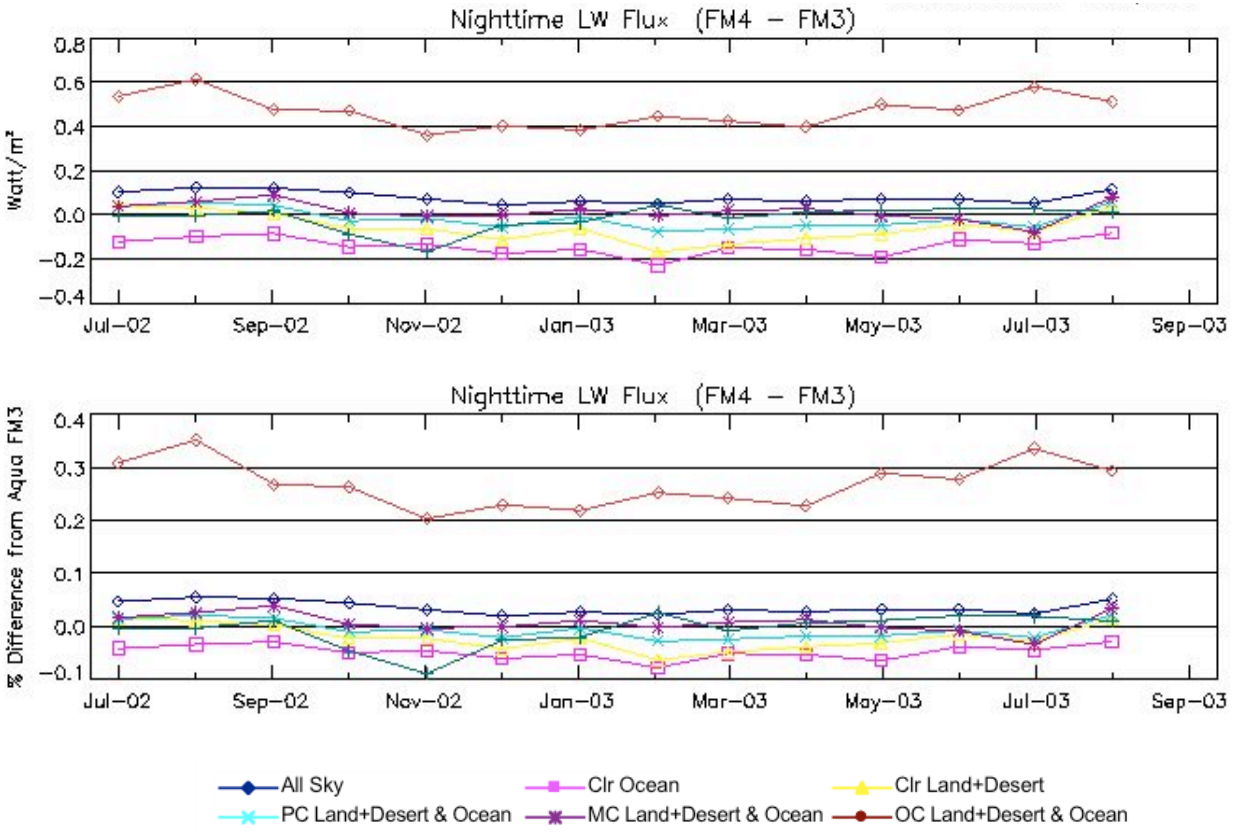
Absolute Difference

Percent Difference

Aqua Direct Comparison

Edition1 Nighttime LW Flux

Co-located nadir measurements



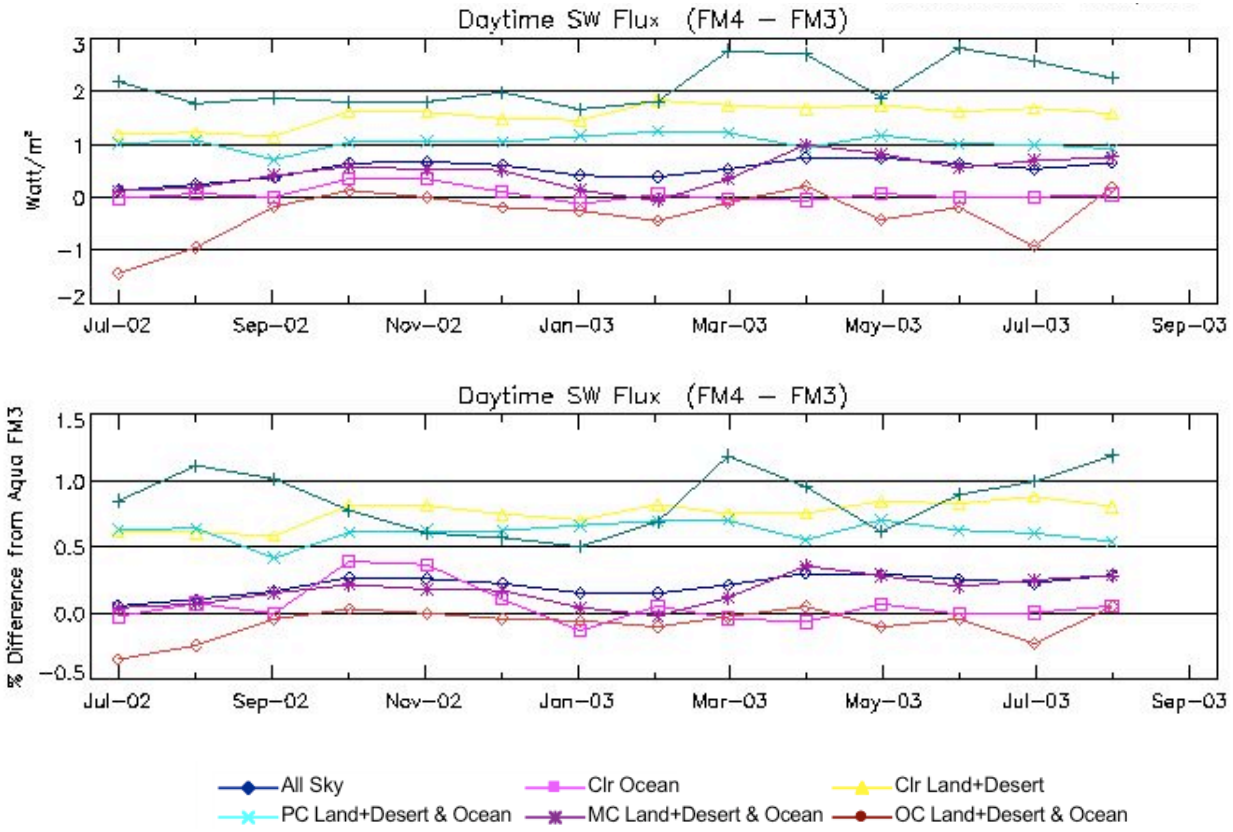
Absolute Difference

Percent Difference

Aqua Direct Comparison

Edition1 SW Flux

Co-located nadir measurements



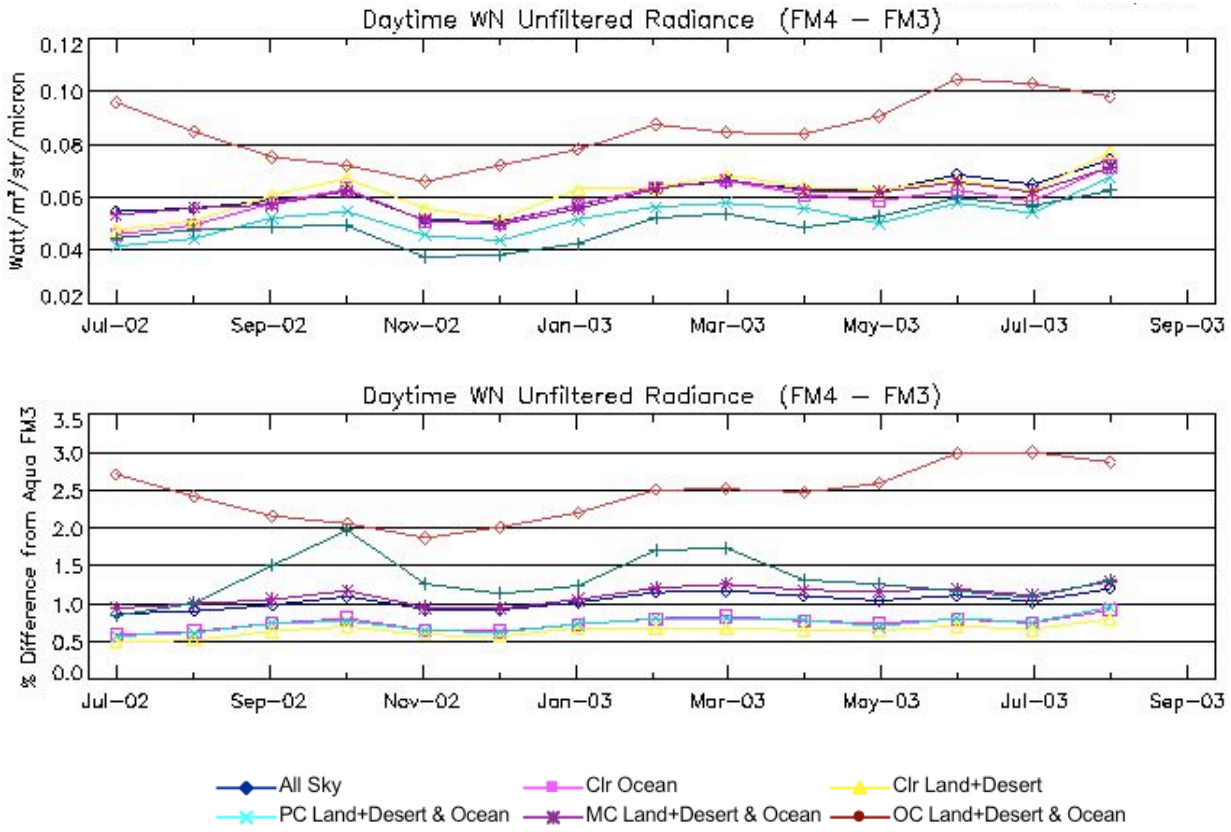
Absolute Difference

Percent Difference

Aqua Direct Comparison

Edition1 Daytime WN Radiance

Co-located nadir measurements



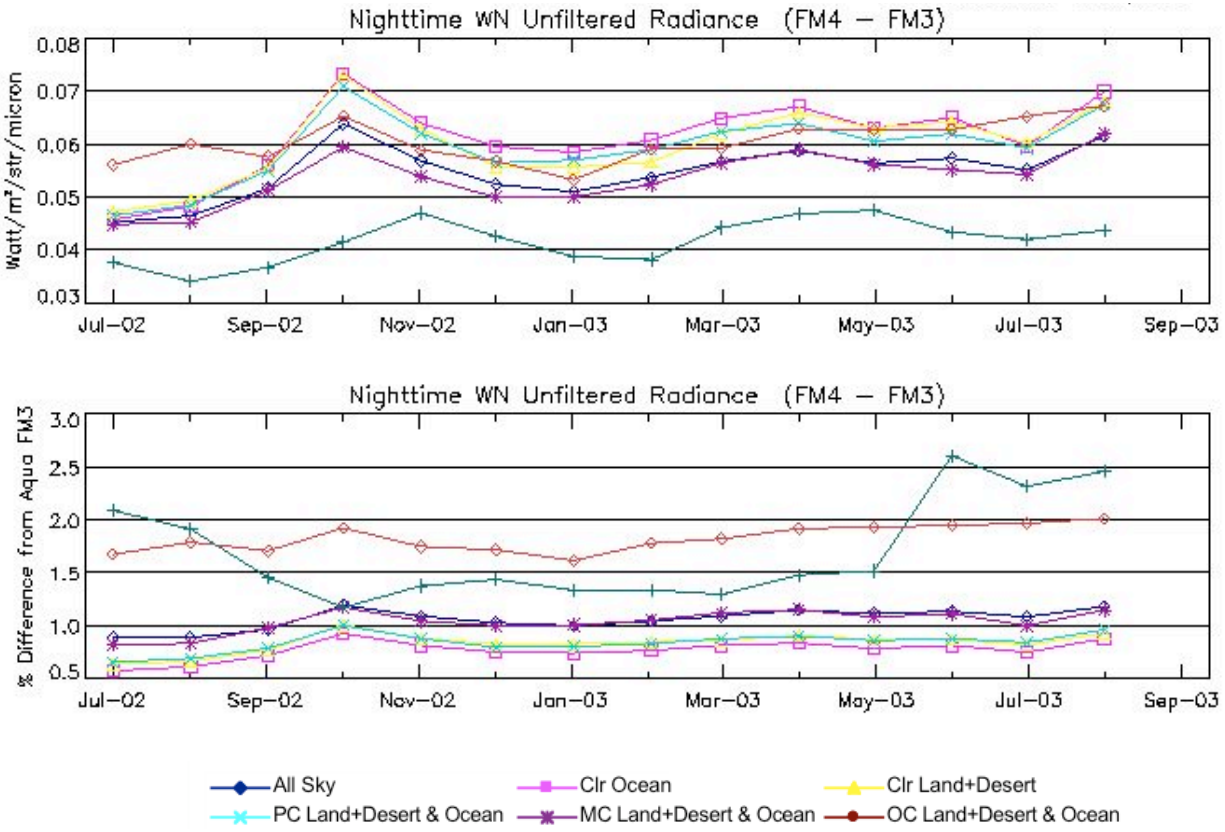
Absolute Difference

Percent Difference

Aqua Direct Comparison

Edition1 Nighttime WN Radiance

Co-located nadir measurements



Absolute Difference

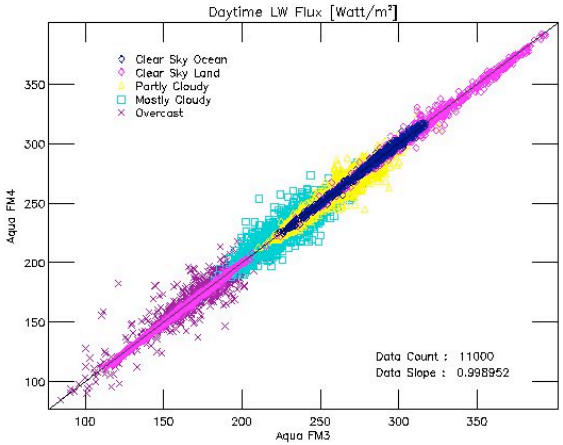
Percent Difference

Aqua Direct Comparison

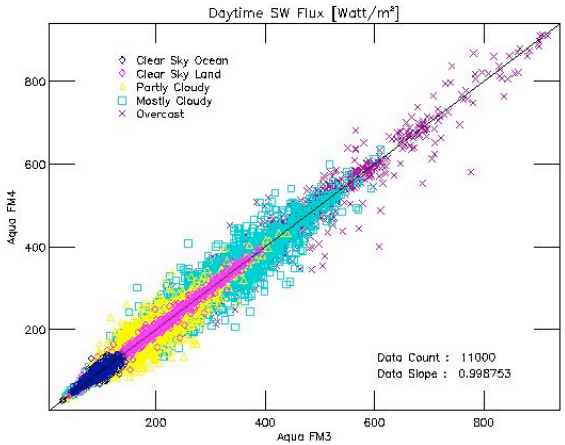
Editon1 ES-8 LW & SW Fluxes, WN radiances

October 15, 2002

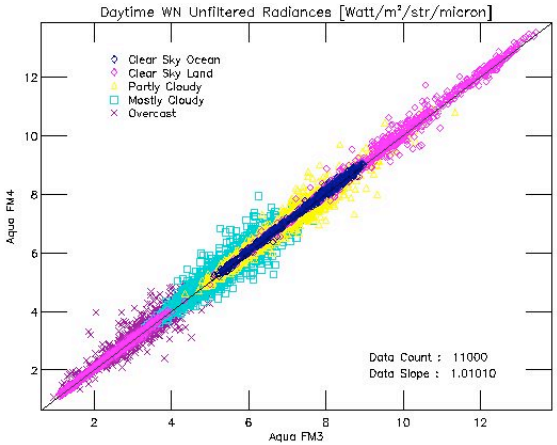
LW

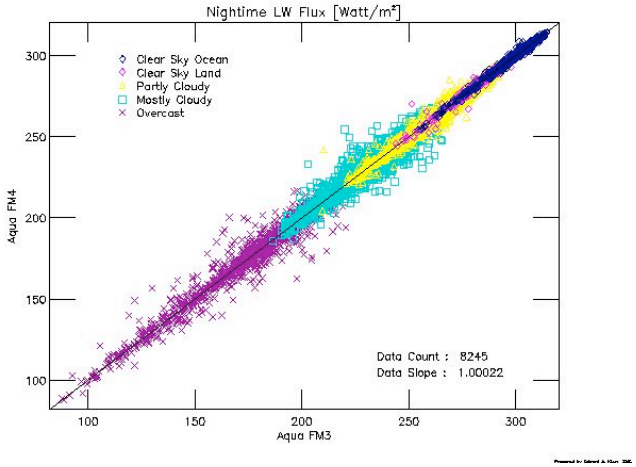


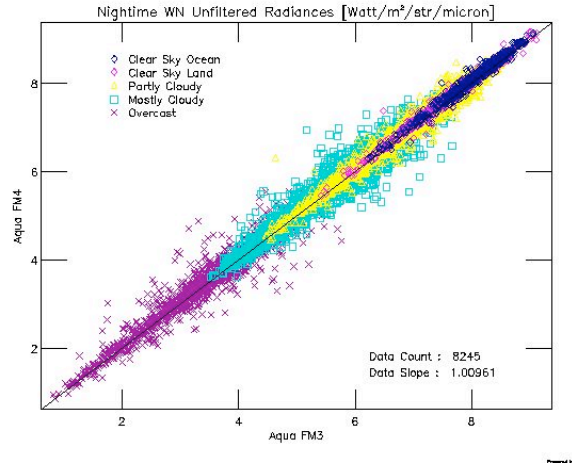
SW



WN



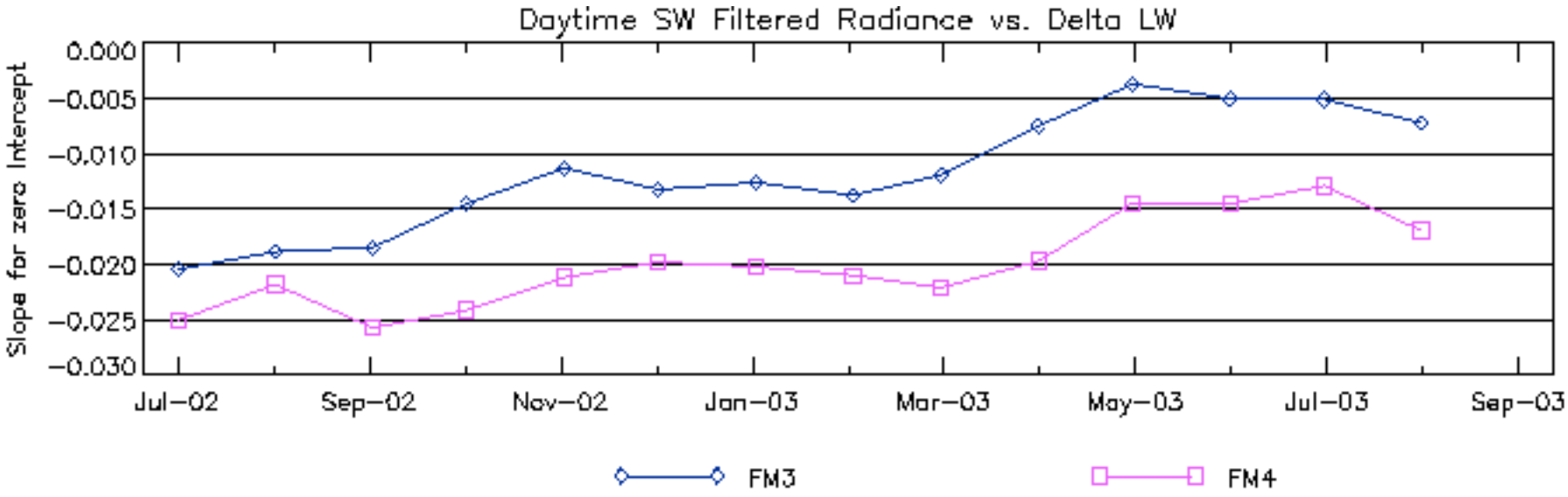




Aqua Three Channel Inter-Comparison

Monthly Unfiltering %-Error

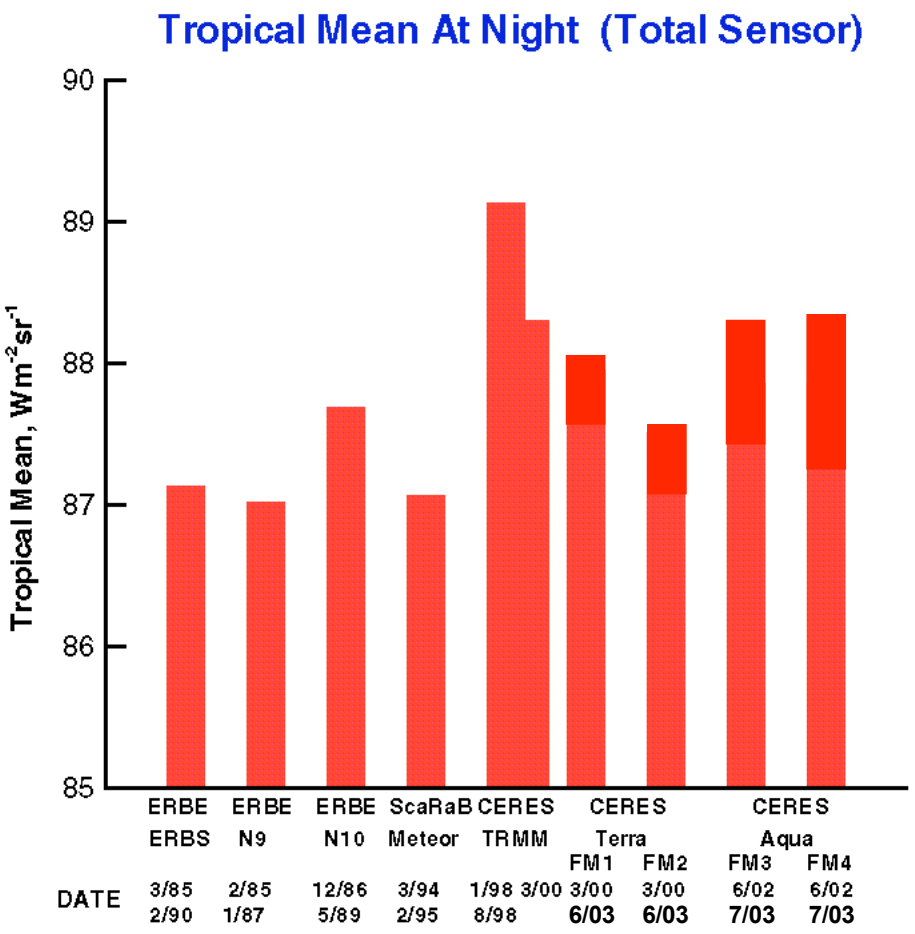
Edition1



Tropical Mean Statistic

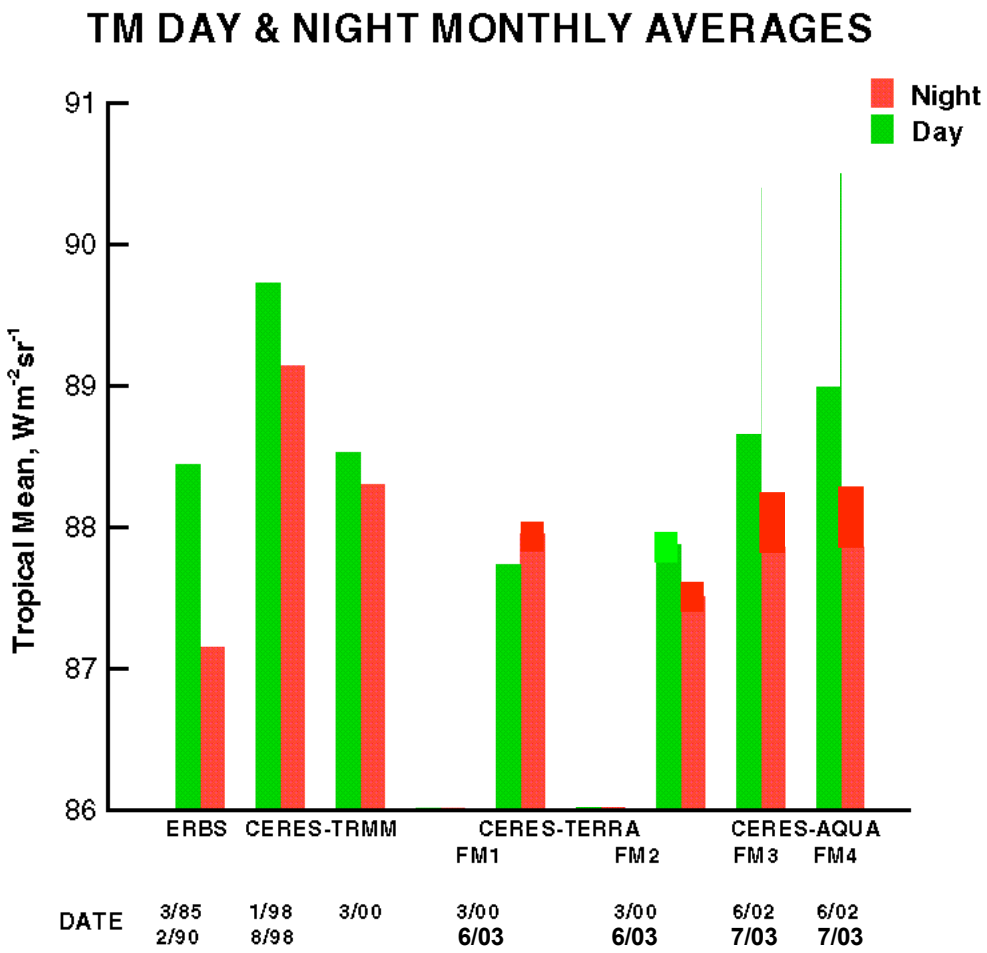
Tropical Ocean All Sky

Terra Ed2, Aqua Ed1



Tropical Mean Statistic

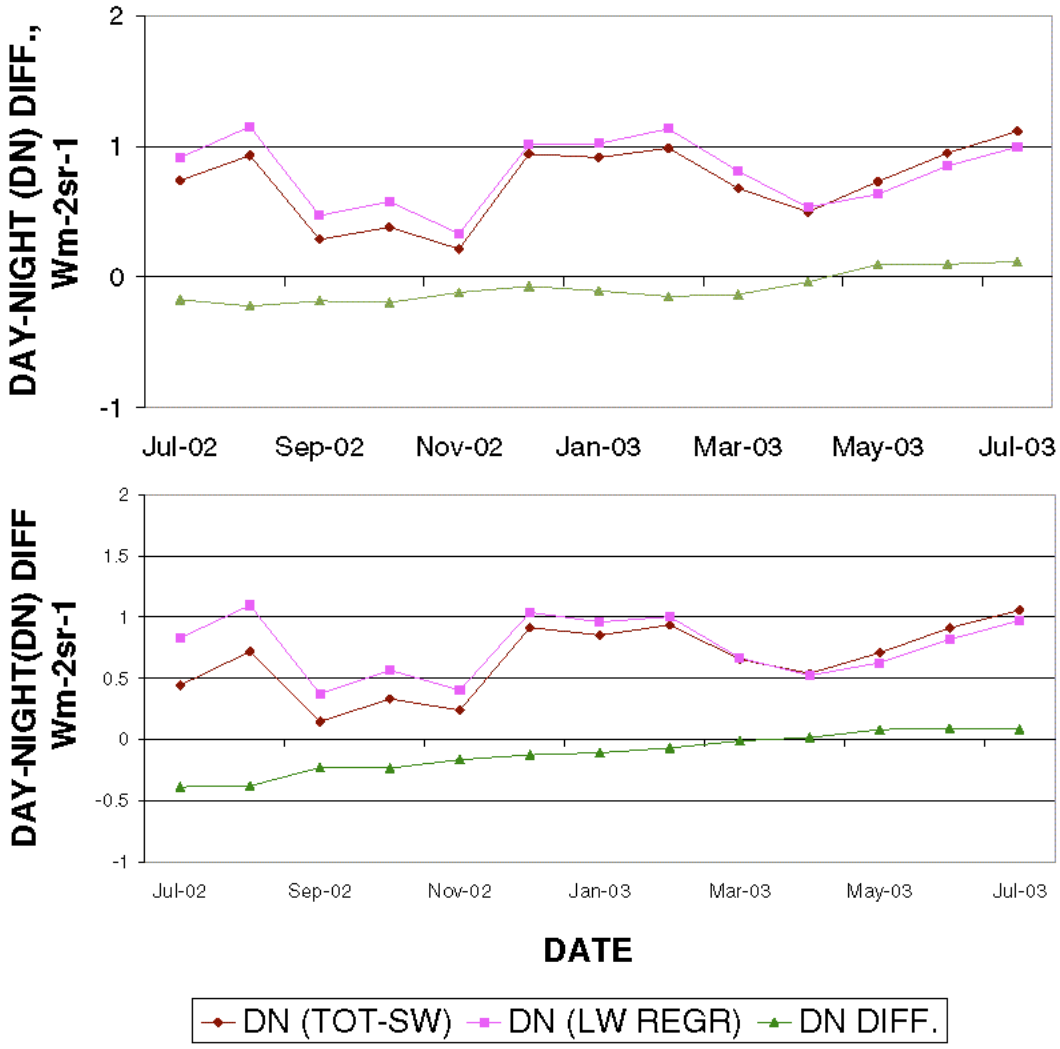
Tropical Ocean All Sky



FM3, Tropical Mean Self Consistency

Tropical Ocean, All Sky

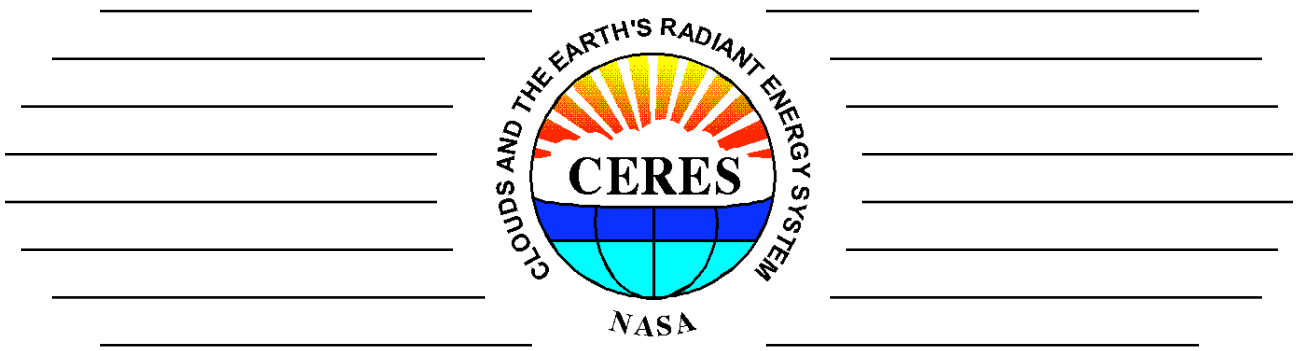
Day-Night Differences



Flight Model 4

Flight Model 3

Terra/Aqua Intercalibration



Instrument Working Group

May 6, 2003

NASA Langley Research Center

Atmospheric SCIENCES

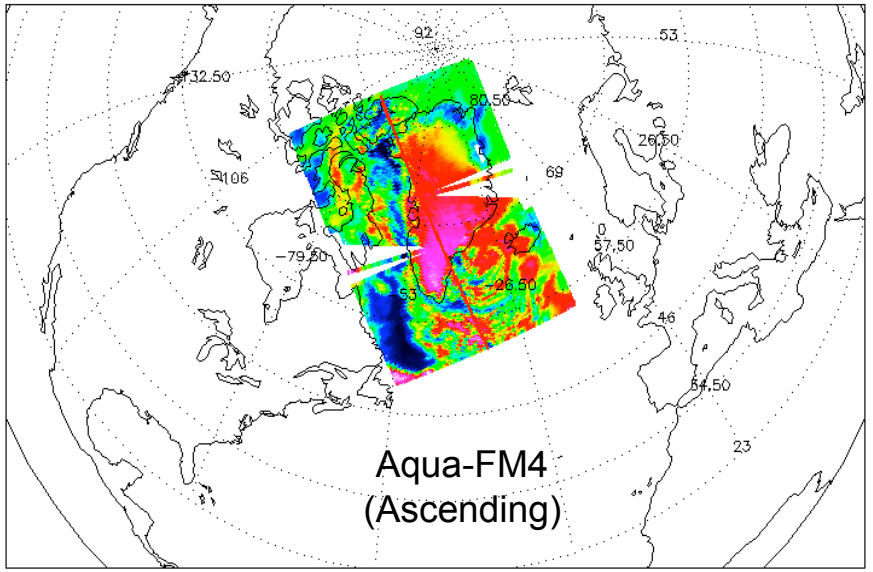
Terra/aqua Inter-Calibration Over Greenland

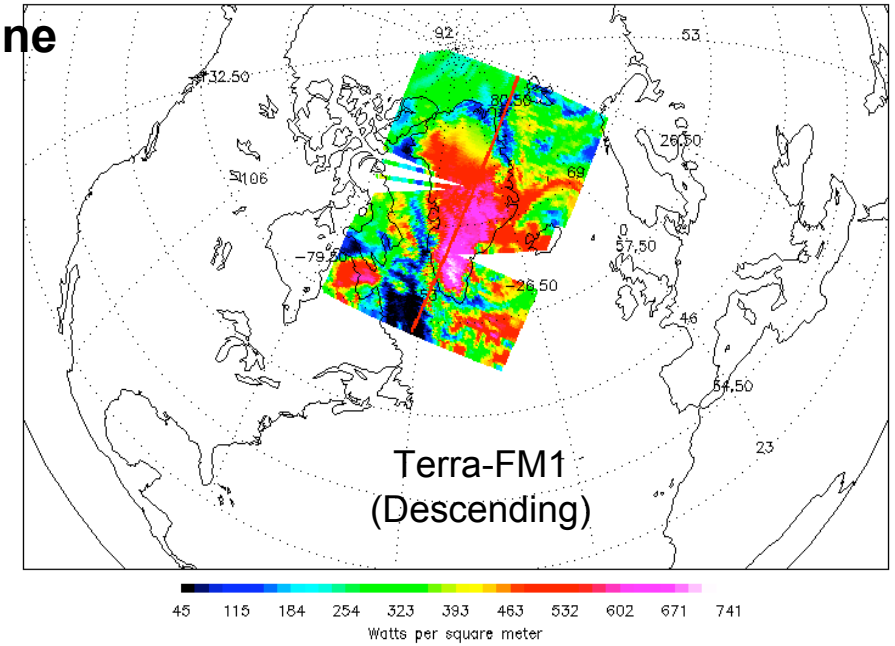
Strategy

- **FM1 and FM4 instruments were utilized**
- **Orbits intersect at 69.5 deg**
- **Temporal matching <15 mins**
- **VZA matched within 10 deg**
- **Scan planes set orthog. to principal plane**
- **Data collected for 5-deg lat. Swath**
- **About 90 sec of data per orbit**

Campaigns

- **07/04-08/22, 2002**
  - **600 orbital crossings**
- **06/13 - 06/29, 2003**
  - **250 orbital crossings**





Terra/Aqua Zonal Inter-Calibration

Direct Comparison of radiances

- **Difference of averages**

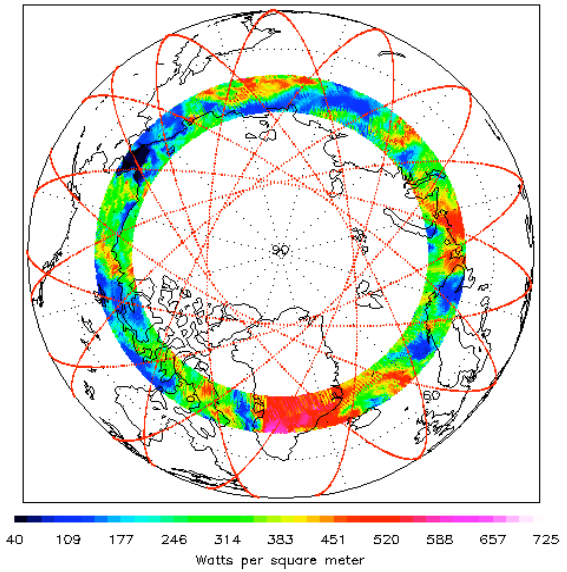
Spatial noise dominates

- **Averaging over 1° x 1° grid-boxes**
- **At least 20 footprints or 75% of area covered**

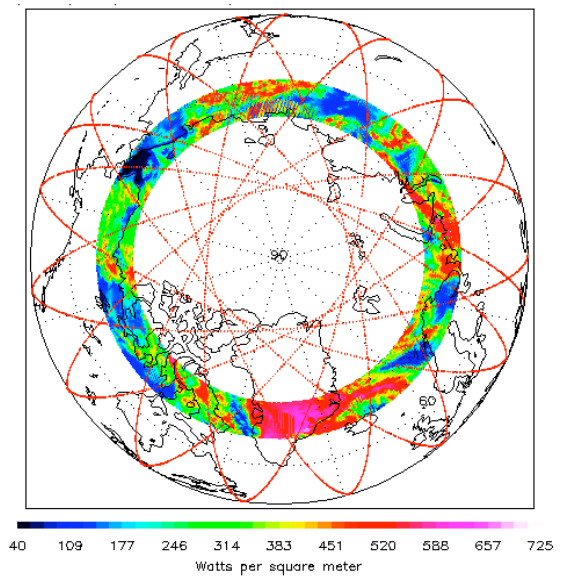
Matching Geometry

- **10° tolerance for viewing zenith angles**
- **20° tolerance for relative azimuth for SW**

Terra-FM1
(Descending)



Aqua-FM4
(Ascending)



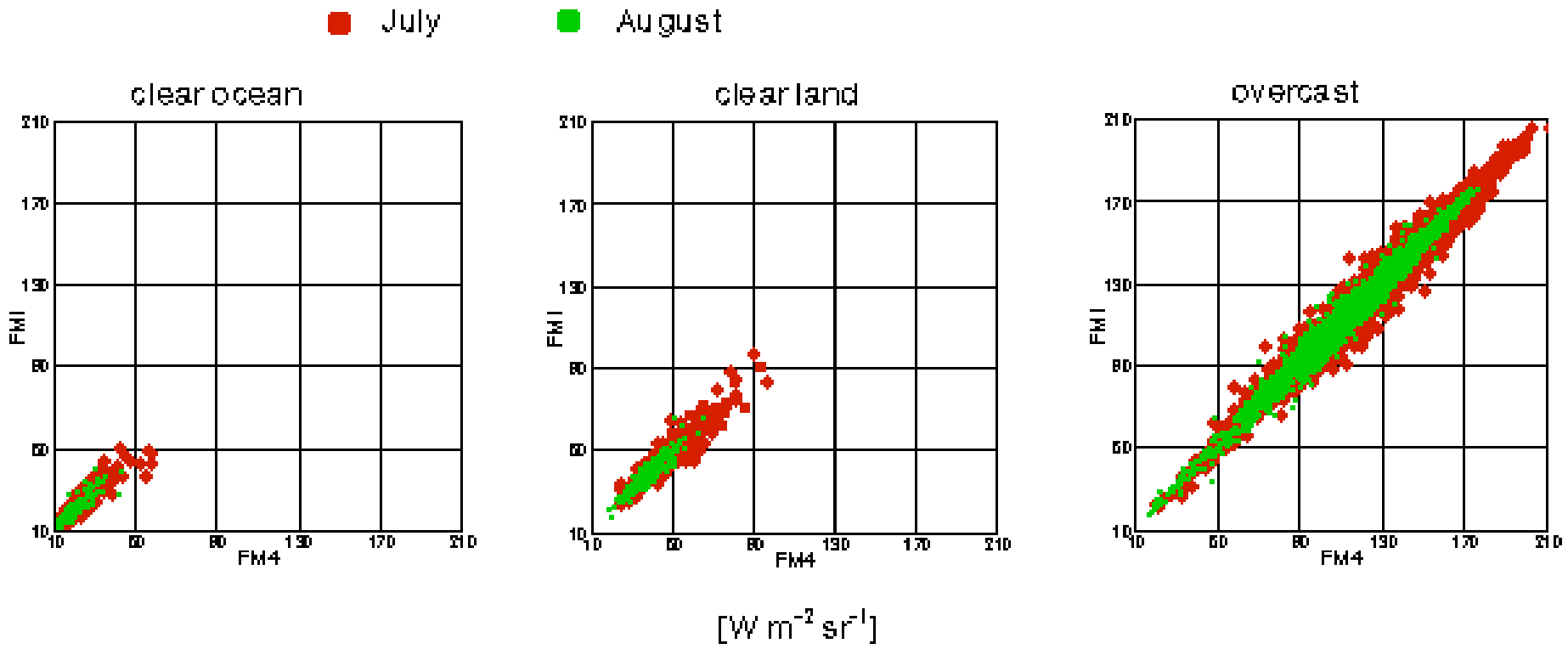
Statistics

Direct comparison of radiances:

- Each orbital crossing is an independent sample
- Difference computed over a grid-box and orbital crossing
- Uncertainty estimated using a 95% confidence level

$\square$ – test: $\square = \frac{t_{\square/2}\square}{\sqrt{N}}$

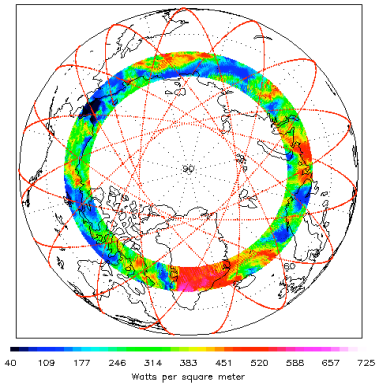
Shortwave radiances



Terra/Aqua Intercalibration

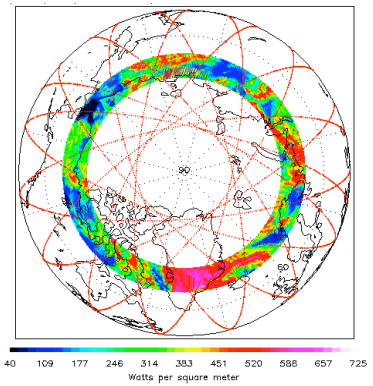
FM1 and FM4 Zonal Comparison

2002



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



	Mean	Abs Diff	% Diff	□□	n	□-test
SW	88.6	-0.36	-0.4	0.74	508	0.08
LW_{day}	76.7	0.54	0.7	0.18	508	0.02
LW_{night}	55.1	0.06	0.1	0.10	527	0.01
WN_{day}	5.5	0.05	0.9	0.03	508	0.00
WN_{night}	3.0	0.03	1.0	0.01	527	0.00

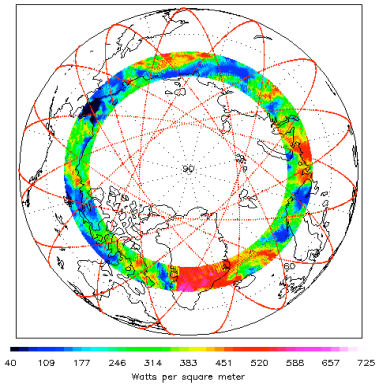
All units in $W/m^2/sr$ **Mean = FM4**
Diff = FM4 - FM1

Data Products: FM1 - Edition2
FM4 - Edition1

Terra/Aqua Intercalibration

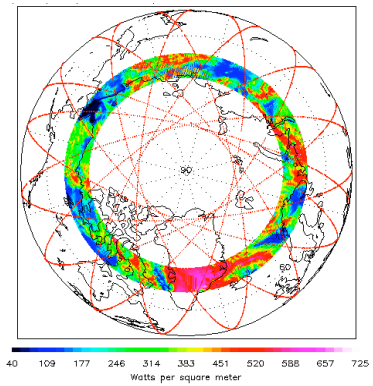
FM1 and FM4 Zonal Comparison

2003



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



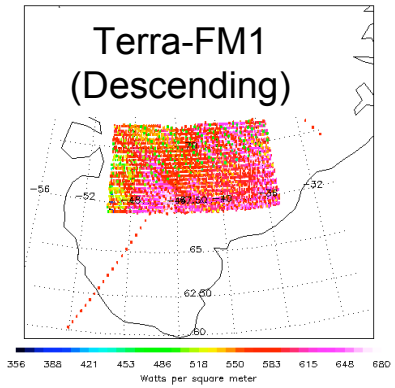
	Mean	Abs Diff	% Diff	□□	n	□-test
SW	92.5	-0.56	-0.6	0.69	236	0.1
LW_{day}	78.4	1.48	1.9	0.31	236	0.1
LW_{night}	55.8	0.13	0.2	0.10	242	0.00
WN_{day}	5.6	0.04	0.7	0.03	236	0.01
WN_{night}	3.1	0.03	0.9	0.01	242	0.01

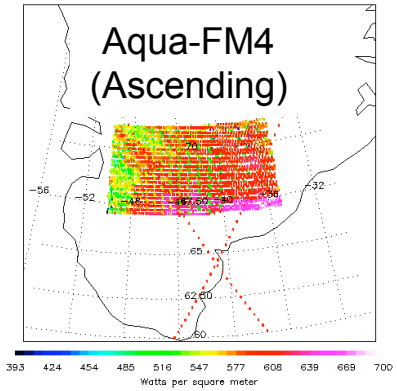
All units in $W/m^2/sr$ **Mean = FM4**
Diff = FM4 - FM1

Data Products: **FM1 - Edition2**
FM4 - Edition1

Terra/Aqua Intercalibration

FM1 and FM4 Regional (Greenland) Comparison





	Mean	Abs Diff	% Diff	□□	n	□-test
SW (2002)	159.1	0.24	0.15	1.05	72	0.3
SW (2003)	163.1	-0.32	-0.2	0.57	25	0.1

All units in W/m^2/sr **Mean = FM4**
Diff = FM4 - FM1

Data Products: FM1 - Edition2
FM4 - Edition1

Conclusions

- Validation procedure for FM1 and FM4 was shown to be well planned and executed
- Data analysis fully demonstrated the 1% consistency in radiance measurements in 2002
- Daytime long-wave difference has grown to 1.9 % in 2003
- CERES instruments have delivered a high quality radiation budget data set since 1998

CERES Cal/Val Summary

Terra

- Edition2 BDS and ERBE-like products available through 12/02
- Factor of 5 improvement in stability & bias for SW and LWday Ed2 products
- Unprecedented stability levels of ~0.1%/yr for CERES climate record

Aqua

- Edition1 BDS products available
- Edition1 ERBE-like products to be released by 6/03
- FM1 / FM4 intercalibrations allow Terra / Aqua instruments to be placed on same radiometric scale.
    - SW, LWnight agreement better than 0.4%
    - LWday agreement better than 0.7%
    - WN agreement better than 1.0%

Terra Edition 2 BDS and ERBE-Like Summary
3/00 - 2/01

Actions

Updated initial flight gains to account for shifts during launch.

Accounted for on-orbit drifts in detector responsivites, or gains.

Accounted for changes in spectral coloration of the SW/TOT channels

Results (for All-Sky cases, 3/00 - 12/02)

		LW$_{day}$		LW$_{night}$		SW		WN$_{day}$		WN$_{night}$	
		Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1
Stability	**W/m^2**	**<.5**	**2.5**	**-**	**-**	**0.1**	**0.5**	**-**	**-**	**-**	**-**
	%	**<.2**	**1.0**	**-**	**-**	**<.1**	**.25**	**-**	**-**	**-**	**-**
Bias	**W/m^2**	**<1**	*******	**.5**	**.8**	**<.1**	**1.0**	**.01**	**.06**	**.01**	**.05**
	%	**<.5**	*******	**<.2**	**<.4**	**<.1**	**.25**	**0.2**	**1.0**	**0.2**	**1.0**